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ELECTRIC SWITCHING OF CARS on the Brooklyn Bridge cable railway will soon be in operation. The 20 motor cars built by the Pullman Palace Car Co., are now being delivered, and are being fitted with the General Electric Co.'s motors and equipment. The cars and the system of operation were fully described in our issue of Feb. 26, 1896, but since then the plans have been somewhat changed. The current will not be taken from an overhead wire, but from a third rail, for which purpose each truck will have on each side a collecting shoe, mounted between the axle boxes. The cars are of the usual type employed on the bridge, each having two four-wheel trucks, and each motor car will have four 50-HP. motors. There are two circuit breakers, a magnetic fuse box, 12 resistances and a magnetic blow-out. The motor car of each train will do the switching at each terminal, and will be able to propel the train load of 120 tons over the bridge (on emergency) at the same speed as the cable, 11.3 miles per hour, and to ascend the grades of 3.78%, which are 1,000 ft. long. The trucks for the new cars were made by the McGuire Mfg. Co.

A LOCOMOTIVE FOR THE SOUDAN RAILWAY, in Egypt, has been built by Manning, Wardle & Co., of Leeds, to the orders of John Birch & Co., of London. It is a tank engine, with outside cylinders, Walschaert valve gear, six coupled wheels, and leading and trailing pony trucks. The railway is a military expedition line of rough construction, with sharp curves and grades up to 2%. The leading dimensions of the locomotive are as follows:

Gage	3 ft. 6 ins.
Fuel	Coke.
Driving wheels	3 ft.
Truck wheels	2 ft.
Driving wheel base	6 ft. 6 ins.
Total wheel base	18 ft. 8 ins.
Cylinders	14×18 ins.
Tubes, diameter outside	1⅞ ins.
Boiler pressure	140 lbs.
Grate area	9.25 sq. ft.
Heating surface, tubes	545.00 sq. ft.
Heating surface, fire-box	62.00 sq. ft.
Heating surface, total	607.00 sq. ft.
Capacity of tanks	1,080 gallons

THE NEW FREIGHT TERMINALS of the Illinois Central R. R., at New Orleans, La., were formally opened Oct. 28, with some ceremony. In the evening Mr. Stuyvesant Fish, president of the railway, gave a dinner to the mechants of the city.

AN UNDERGROUND RAILWAY IN PARIS, about 11,054 ft. long, is to be built to transfer the terminal station of the Compagnie d'Orleans from the Place Valhubert, some distance up the Seine, to the Quai d'Orsay, opposite the gardens of the Tuileries and in the heart of Paris. The new line will follow the left bank of the Seine and will be, for the greater part, in a double track masonry tunnel, with the floor just above the level of the water in the river. About 2,027 ft. near the present station will be a sunken track, open above. The total estimated cost is about $4,600,000.

AN AMERICAN-CHINESE SYNDICATE, says a news item from Pekin, has promised to advance 30,000,000 taels, or less than $15,000,000, for the construction of the Han-Kow & Peking railway, a line 700 miles long, and crossing 27 rivers, including the Hoang-Ho. Rumors of similar Chinese railway construction with American money are, unfortunately, abundant; and whether this will result in anything more substantial than a news item remains to be seen.

A DEVICE FOR RAISING SWING BRIDGES for the purpose of renewing the roller system and making other turntable repairs has recently been tested with very successful results at Chicago, Ill. This device is the invention of Mr. J. E. Roemheld, Engineer of Bridge and Viaduct Repairs, Chicago, Ill., and it was first used in raising the Clark St. bridge, which is a double roadway, three-truss structure 220 ft. long, 58 ft. wide, and weighs 800 tons. Work was begun at 10 a. m. and finished at 5:30 p. m., during which time the set of 80 rollers was replaced, engine and boilers overhauled and sundry minor repairs made. No falseworks or jack screws were used and the labor force was 20 men. The raising device consisted of a series of interlocking cast-steel wedges so arranged that the bridge is turned up onto them and thus raised. In a future issue a full illustration and description of these wedges will be given, but at present it can only be stated that they worked with absolute success.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision between a fast freight train and three loaded oil tank cars standing on the track at Wapakoneta, O., on the Cincinnati, Hamilton & Dayton R. R. The engineman, fireman and one brakeman were killed, and the wreck caught fire; 12 freight cars and the pumping station of the Manhattan Oil Co. were destroyed by fire. ——An express train on the Eastern Division of the Boston & Maine R. R. ran into the open draw of the bridge over the Saugus River, near West Lynn, Mass., Oct. 30. The train was the "Flying Fisherman," from Boston to Rockport, and the drawbridge had been almost closed when the train reached it. Gates were closed across the track 500 ft. from the bridge, and red lights were displayed, and this was admitted by the engineman, but he claimed that the brakes would not hold the train. The engine went through into the river, with its rear end resting upon the abutment. Nobody was hurt.

A GAS EXPLOSION IN A MINE occurred at Wilkes Barre, Pa., Oct. 29. The explosion occurred in No. 3 shaft of the Lehigh & Wilkes Barre Coal Co., killing four men, while two men of the rescue party were suffocated by the after damp.

DEFECTIVE BUILDING WORK IN NEW YORK has again been detected. A 7-story building for manufacturing purposes is being erected at 508 and 510 Broome St., and on Saturday it was noticed by an inspector of the Building Department that the walls were bulging. Mr. Constable, Superintendent of the Department, made a personal inspection, and sent for contractors to shore up the walls and secure them by wire cables. It is said that defective construction, urdue haste in the erection of the three top stories, and the jarring from the engine used to hoist material, contributed to the failure of the work.—— Building inspectors have also found a dangerous building at 158 Leonard St., which was in use as an Italian school. The building had settled so that the walls were cracked and had bulged out, while the floors had sagged down considerably. Steps were at once taken to shore up the building.

CIVIL SERVICE EXAMINATIONS will be held by the New York City Civil Service Board as follows: Enginemen, Nov. 11; sanitary inspector for the Health Department, Nov. 12; instrument maker for the Fire Department, Nov. 16; bacteriologist, salary $1,200 per year, and assistant bacteriologist for the Health Department, $600, Nov. 24; second deputy superintendent of buildings ("competent architects or builders of at least 10 years' experience"), Nov. 30. Particulars may be obtained of Mr. Briscoe, Secretary of the Commission, Criminal Court Building.

EXTENSIVE IMPROVEMENTS TO THE WATER SUPPLY of Baltimore are proposed, in accordance with plans outlined in a report by Mr. Samuel M. Gray, M. Am. Soc. C. E., of Providence. The estimated cost of the work is $1,985,700, divided as follows: 75,000,000-gallon reservoir and land for same, $450,000; two 17,500,000-gallon pumps in place, $130,000; one 10,000,000-gallon pump, $35,000; five 150-HP. boilers in place, $15,000; pumping station, $90,000; pipe system, $1,059,700; screens and accessories, $12,800; high service improvements, $193,200. Bids for 26,000 tons of cast-iron pipe will be received until Nov. 16, as stated in our advertising columns. It is reported that the other contracts will not be let until next spring. Mr. W. L. Kenly is Chief Engineer of the Water Department.

THE NAVAL BUREAU OF ORDNANCE, says Capt. Sampson, Chief of the Bureau, in his annual report, has built 450 guns of large caliber, has 89 partly built and has only condemned two out of this number in official tests. All of the 6-in. guns on hand are to be converted into rapid-fire guns, and the appropriation of $250,000 for reserve guns is being utilized in constructing two 8-in., two 12-in. and two 13-in. guns. Smokeless powder is on hand for all guns up to 6-in. caliber. During the year 2,262 tons of armor have been delivered, 684 tons of this being reforged plate. The two armor-making companies now claim an annual capacity of 8,400 tons. As auxiliary cruisers the department has inspected and accepted 19 American steamers on the Atlantic coast and 9 on the Pacific coast. These ships will require 46 6-in., 27 5-in., 104 4-in., 54 6-pdr. 8 1-pdr. and 112 machine guns. The estimates for the next year aggregate $9,164,620, the largest item being $7,720,706 for the armament of vessels authorized.

THE UNITED STATES NAVY, says Chief Constructor Hichborn in his annual report, now contains 110 vessels of all classes; of these 30 are armored, including 8 battleships, two cruisers, one ram, 6 double-turreted monitors and 13 single-turreted monitors. Three other battleships are under construction. There are now in commission 25 new steel cruisers, with 16 iron and wooden cruisers.

FOREST DESTRUCTION AND FRESHETS in mountain streams are discussed in the annual report of Mr. T. Jefferson Coolidge, Treasurer of the Amoskeag Cotton Mfg. Co., of Manchester, N. H. For some years past there have been heavy spring freshets in the Merrimac River (that of 1896 compelling a general shutting down of the mills at Manchester), while in summer the water is lower than in former years. This alternation of very high and very low water is attributed by Mr. Coolidge to the cutting down of forests around the headwaters of the Merrimac, the Pemigewasset and other affluents. The woods held back the water, but now that they have been largely destroyed the rain, running rapidly over the surface of the ground, which is baked by the sun or frozen hard by the winter cold, pours all at once into the streams, turns them into roaring torrents, and finds its way all at once into the Merrimac, sweeping everything before it. In a few days the river sinks rapidly and becomes in time of drouth an insignificant stream.

THE PENNSYLVANIA FORESTRY COMMISSION, Wm. F. Shunk, Engineer, reports that there are in that state 13,973,737 acres of cleared land, and 9,099,817 acres of woodland. Both Mr. Shunk and Prof. Rothrock, the Forestry Commissioner, recommended the purchase of forest reserves by the state, both to better protect standing timber from fire and to perpetuate our forests. They say that unless something of this kind is done at once the state will bo denuded of valuable timber within the next 15 years. During recent years one firm of lumbermen has lost 150,000,000 ft. B. M. of timber by forest fires. In the past season one tract of 125,000 acres was thus devastated.

DURING THE CONSTRUCTION OF THE MELAN arch bridge, at Topeka, Kansas, the remains of another bridge were encountered in the foundation, a bridge forgotten by nearly everyone now living in Topeka, though it was only built late in "the fifties." Topeka was then a village, and a bridge was built across the river, with pile-piers and a swing-span for the accommodation of passing steamboats. The bridge fell almost immediately after its completion, and the wreck was soon buried in the sand by a shift in the channel and forgotten. The oak piles in the foundation of the old pivot-pier, which were encountered in founding the Melan arch, were in an excellent state of preservation, and they are being withdrawn for use under the new piers.

PANAMA CANAL WORK, says a Panama news item, is being "pushed" on the Culebra Section with a force of 150 negroes. The American system of handling earth by towers, endless chain of buckets, etc., copied from some of those used on the Chicago drainage canal, has been introduced on the Empire Section, and is said to work well. M. Belin, the Director-General for the new canal company, has arrived at his post. He is not an engineer, but a lawyer, formerly connected with the administration of the old canal company.

WOODEN PAVEMENTS seem to have little connection with politics, other than in the contract stage of their existence; but the authorities of Chicago, through the Chief of Police, have forbidden the use of the wooden blocks for making election bonfires. Boys have been caught tearing up the blocks on Jackson Boulevard and storing them away for this purpose.

BRICK PAVING FOR COUNTRY ROADS is being tried near Monmouth, Ill. About 3,000 ft. of brick pavement have been laid in Monmouth township (Warren county), there being a single course of brick laid on 6 ins. of sand, while a strip of 30 ins. of broken stone paving is laid on each side of the brick. The cost is said to be less than $5,000 per mile.

THE THIRD AVE. DRAWBRIDGE OVER THE HARLEM RIVER; NEW YORK CITY.

We illustrate herewith the drawspan for the new Third Ave. bridge over the Harlem River, New York city, which is now completed, and will be opened to traffic as soon as the approach spans are finished. This is one of the largest and heaviest drawbridges ever built, and it is notable not only for its size, but for the attempt which has been made to improve its appearance. While the truss is of the general form which has become a standard for swing spans of this class in America, curved outlines have been adopted for the top chord in place of the angular outline which such a truss usually presents, and the top chord has been emphasized in the construction.

There may be some things in the field of engineering construction which are more awkwardly ugly than the ordinary swing span truss as usually constructed, but we do not now recall what they are. The attempt to remedy this by the introduction of curved outlines which has been made in the present case is a most interesting experiment, and opinions will doubtless differ as to its success. We are inclined to believe that a more radical departure must be made from conventional forms if the swing span is to be made a thing of beauty.

As an engineering structure the bridge is especially notable for its use of multiple-intersection lattice trusses in a structure of such magnitude. These, with the curved top chord, have made necessary great care and accuracy in the shop and field work.

The span is 300 ft. long and 87 ft. 6 ins. wide over all. The Act of Congress authorizing the rebuilding of the Third Ave. bridge, requires a clear headway of 24 ft. above high water. The limited space available for approaches on the south side of the river made it necessary to design the draw with a very thin floor, not over 20 ins. deep, in order to keep the approach grades down to 3%. This made it necessary to place the trusses near together, and the bridge is therefore built with four trusses, dividing the floor into two carriage roadways and a roadway for a double track electric railway, the latter being between the middle trusses. The three roadways are each 20 ft. wide, and two sidewalks 9 ft. wide are carried on cantilever brackets outside the trusses. The depth of the trusses is about 38 ft. at the center and 18 ft. at the ends. The floor system is of buckle plates, covered with concrete and an asphalt pavement for roadways and sidewalks. The weight of the draw is 2,500 tons, and this is carried on a turntable of 60 ft. diameter, which is said to be the largest ever built, that of the 400-ft. four-track drawbridge carrying the New York Central R. R. across the Harlem River being 54 ft. diameter. There are 80 wheels, 24 ins. diameter and 12 ins. wide, running on a track 60 ft. in diameter. The bridge can be turned easily by hand power.

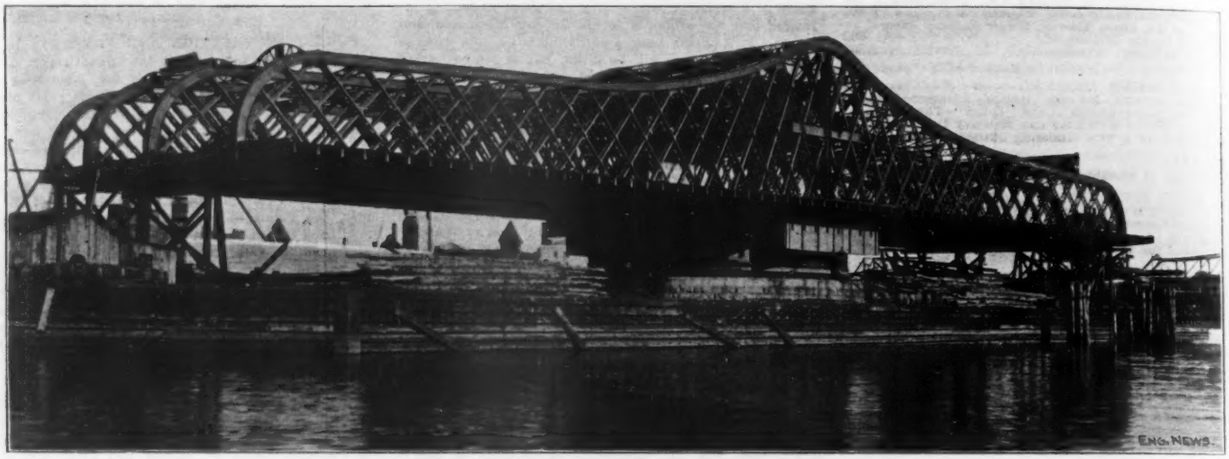
The traffic over the bridge and on the river is very considerable, being approximately equal to that of the Chicago River and the main bridges across it, and this traffic is rapidly increasing. The traffic over the temporary drawbridge at Third Ave., during the 24 hours between 12 p. m., July 9, and 12 p. m., July 10, included 4,996 vehicles, and the draw was opened 60 times during that period, the aggregate time of opening being five hours. The traffic on the Harlem River amounted to 5,910,376 tons in 1893, while foreign shipping from the port of New York amounted to 7,000,000 tons in the same year.

In view of this very heavy traffic it was therefore important to devise such machinery for operating as would swing the bridge quickly and would reduce to the lowest degree the liability to failure. The problem to be considered was the best method of swinging a bridge span weighing 2,500 tons through a quarter of a circle in two minutes, several times a day. This work can be done by a 50-HP. engine but in order to prevent closing the bridge for repairs or minor accidents, a duplicate plant is fitted, consisting of two 60-HP. boilers, and two double cylinder (7 × 10 ins.), inclined, oscillating engines, either of which can operate the bridge at half speed. The boilers also supply steam for the end locking gear, and for a 35-HP. dynamo for lighting purposes. The machinery is placed in a power-house between the trusses. In preparing to open the bridge, the engineman first signals the gatemen, who close the gates on the outer end of the fixed approach spans. He then simultaneously withdraws the central locking bolts, runs up the eight supporting nuts and eight hydraulic rams under the ends of the four trusses, and also raises the ten aprons (four for sidewalks, four for roadways, and two for electric railway) which cover the space between the draw and the fixed spans, while at the same time the rail connections of the electric railway tracks are also raised. These operations are performed simultaneously in about 10 to 12 seconds. The time occupied in swinging the span is such that the whole time occupied will not exceed two minutes for a full opening, and two minutes more for closing and locking the bridge.

There are two 117-ft. plate girder deck approach spans, one at each end of the draw, and these have a 50-ft. roadway paved with granite, and two 12-ft. sidewalks paved with limestone flags. Beyond these are masonry approach viaducts, that on the north side being in line with the bridge, while at the south end the approaches curve away in either direction, almost at right angles to the bridge. The north approach is 60 ft. wide, and the two south approaches are 35 ft. wide. These approaches have no sidewalks, the sidewalks of the bridge proper being reached by two stairways 12 ft. wide. A movement is on foot to have another approach from the Southern Boulevard, on the north side, and to extend one of the curved approaches on the south side to the west of Third Ave. All the stone work is rock-faced, except the cut granite balustrades, railings and copings.

The detail bids for this entire structure were given in full in our issue of Sept. 7, 1893. The total cost of the bridge, including land, will be from $2,000,000 to $2,500,000.

The bridge was designed by Mr. Thomas C. Clarke, M. Am. Soc. C. E., and the machinery was also built under his specifications and direction. Mr. Geo. W. Birdsall is engineer in chief of the whole work by virtue of his position as Chief Engineer of the Department of Public Works. The general contractor was Mr. Isaac A. Hopper, of New York. The drawspan was built by the Phoenix Bridge Co., of Phoenixville, Pa., of which Mr. John Sterling Deams, M. Am. Soc. C. E., is Chief Engineer. The machinery was built by Joseph Edwards & Co., of New York city.



DRAWBRIDGE OVER THE HARLEM RIVER AT THIRD AVE., NEW YORK CITY.
Thomas C. Clarke, M. Am. Soc. C. E., Engineer. Phœnix Bridge Co., Builders.

NOTES OF A TRANSCONTINENTAL TRIP.

IV.

The Great Salt Lake.

On July 12 I took a trip to this remarkable lake, which is about 15 miles from Salt Lake City, and has two pleasure and outing resorts reached by rail. Garfield Beach is reached by a branch of the Union Pacific Ry., and Saltair Beach (which was the place visited) is reached by the Saltair Ry. (a branch of the Rio Grande Western Ry.). This latter line has engines built by the Rhode Island Locomotive Works, of Providence, R. I., and they are painted in an unusually gaudy style, with brilliant red wheels and a liberal allowance of gold leaf and varnish. The first car of the train is a closed combination baggage and smoking car, the other cars are open-sided excursion cars with 20 transverse seats, resembling in style the cars of the Coney Island lines, so familiar to New York people. The train lands its passengers at the entrance of the great pavilion shown in Engineering News, Nov. 9, 1893, from each side of which extends a curved trestle with rows of dressing rooms for bathers. The water of the lake is remarkably clear, and the bottom is of fine sand as soft as a velvet carpet. It was also pleasantly warm and afforded a most enjoyable bath. The water has a specific gravity of 1.107 and contains 17 to 27% of saline contents (varying at different parts of the lake.) The bulk of the saline contents is common salt. The Dead Sea has a specific gravity of 1.116 and contains about 24% of saline contents, while ordinary sea-water has a specific gravity of 1.026, and contains 3 to 5% of saline contents. The lake is about 80 miles long and 30 to 50 miles wide, with an average depth of 20 ft. and a maximum depth of about 80 ft. It receives the Jordan, Weber and Bear Rivers, but has no outlet. There are two large islands, 12 and 16 miles long, with hills as high as 3,000 ft., and having good fresh water springs; besides these there are a number of smaller islands. On the south side are the mountains, while dry desert and salt

marshes form the south and west sides, and irrigable lands are on the east side. The old water line is plainly visible on the rocky sides of the mountains.

Salt Lake City to San Francisco (So. Pacific Ry.).

I left Salt Lake City on the Pacific mail train of the Rio Grande Western Ry., July 13. The line follows mainly the course of the lake shore to Ogden, 37 miles, where the Rio Grande Western Ry. terminates by a junction with the Union Pacific Ry. There is a handsome station here, built beside the tracks and having no trainshed or platform sheds. The through cars for this latter line are here attached to the Overland Limited Express which runs over the Chicago & Northwestern Ry. and Union Pacific Ry. to Ogden, and thence over the old Central Pacific Ry. (now the Central Pacific Division of the Southern Pacific Ry.) to San Francisco. This train, on July 13, was made up of seven cars; a fast freight car, baggage and mail car, day car, tourist sleeping car, dining car and two sleeping cars. It was hauled by a ten-wheel engine, built by the Cooke Locomotive Works, of Paterson, N. J., one peculiar detail of which was a step attached to the crosshead, evidently to give the cleaners access to the running board without climbing up on the front end. On the Sacramento Division, running between Sacramento and Truckee, are some immense twelve-wheel engines with cylinders 22 × 26 ins., and weighing 173,000 lbs., with 145,000 lbs. on the eight driving wheels. These engines are reported by Mr. H. J. Small, Superintendent of Motive Power, to be giving remarkably good service on the heavy mountain grades over the Sierras.

Near the track, at Sacramento, were seen the works of Schaw, Ingram, Batcher & Co., manufacturers of riveted sheet, steel and iron pipe for mining, irrigation and power purposes.

Southern Pacific Ry. (Central Pacific Division).

The Central Pacific Ry. was one of the two great lines whose construction was assisted by the United States government in order to secure a transcontinental railway line. The total amount of subsidy issued to the Central Pacific Ry. was $27,855,680, and about 12,000,000 acres of land. The line was to extend from San Jose to Ogden. Work was commenced at Sacramento in February, 1863, and the connection with the Union Pacific Ry. was made on May 10, 1869. The communication with San Francisco was at first by steamer, until the Western Pacific Ry. was opened from Sacramento, and this was later superseded by the California Pacific Ry., which has a route 60 miles shorter, but includes a ferry crossing of the Carquinez Strait. The Central Pacific Ry. is now leased to the Southern Pacific Ry. for 99 years from April, 1885.

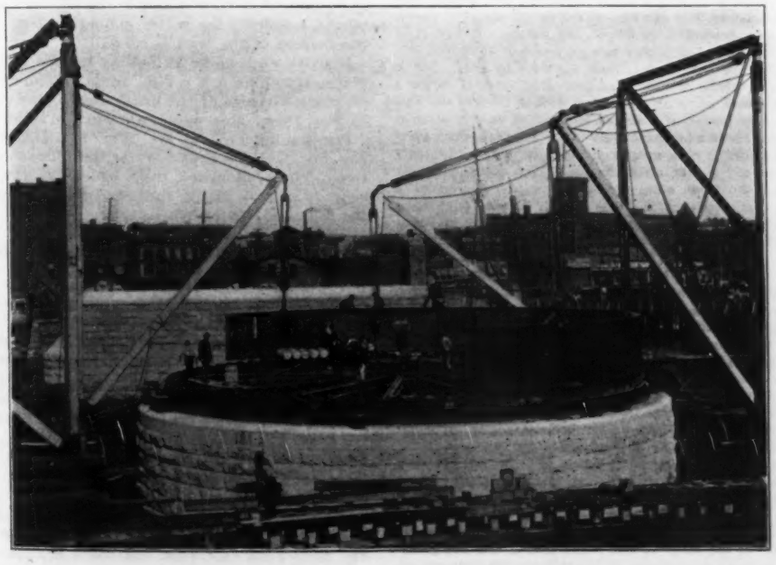
On leaving Ogden the railway at once begins to ascend from the level of the Jordan Valley, the grades being pretty heavy in places and combined with sharp curves. The valley here is composed of salt marshes and desert land, and high upon the hills is plainly visible the water line of the former level of the lake. For several hours the dark blue lake and its mountain islands are present to the view; in fact as far as Monument, 77 miles from Ogden. For many miles one sees on the south side of the line evidences of a partly graded roadbed, with cuts and fills, the grade being usually below that of the existing line, but running out into the latter at Promontory, Corinne, etc. This is part of the line built by the Union Pacific Ry. when the transcontinental line was under construction, and the point of junction of the Union Pacific Ry. (from the Missouri River) and the Central Pacific Ry. (from the Pacific Coast) had not been decided upon. Both companies built as fast as possible in order to gain the subsidies for length of line, and as many men were put on as could work without getting in each other's way. The graded lines overlapped for nearly 200 miles, but the actual meeting of the tracks was made at Promontory, on May 10, 1869. Ogden was afterwards settled upon as the junction point. At Kelton, 92 miles, is the water supply station for the westbound trains, which here strike across the northern edge of the Great American Desert for a distance of nearly 100 miles, the line being on an ascending grade and reaching an elevation of 5,975 ft. at Toano, on the western border of the desert. The general appearance of the desert is similar to that of the Utah Desert, already described, being a sand with sufficient loam to form a thin, flat scale like the cracked mud bottom of a dry pond, and to form a thin, slimy mud when wet by the occasional furious rainstorms, which are preceded by wind and sand storms. The train passed through one of these storms, the blinding sand being followed by a drenching rain, which effected a welcome cooling of the atmosphere.

From the desert the line ascends the Cedar Pass, climbing the Divide between the desert and the Humboldt Valley. Here the snow sheds and snow fences begin to appear, and the summit is reached at Moors, 6,167 ft. above sea level. Beyond this there is an almost continuing descent to Browns, 610 miles, the elevation of which is 3,929 ft. About 140 miles of this distance is across the desolate Nevada Desert, which, however, this train crosses at night. The speed is considerable at times, 40 to 50 miles per hour, but though the track is fairly easy riding for the Pullman cars, it was the least easy of any thus far encountered. Reno, 4,497 ft. elevation, is the junction for Carson City and Virginia City, in the great silver and gold mining district of which the Comstock mines are the most celebrated. Here begins the ascent of the Sierra Nevada, amid the scenery of pine-clad slopes and peaks which are characteristic of this region and which are a great relief after the sand and dust and glare of the Utah, American and Nevada deserts. For many miles the line follows the rushing and tumbling clear Truckee River, and, rising from it are seen the long, steep chutes of plank, down which the logs are sent from the hill tops to the river. Unfortunately, the snowsheds begin at Truckee and continue almost without a break for 40 miles, so that, as there is no outside line for summer traffic (as on the Canadian Pacific Ry.) much of the view is lost. Glimpses of snow patches are seen through the loopholes, however. The station at Summit (elevation, 7,017 ft.) is in the snow shed, and at intervals the sheds are wide enough for a side track for passing trains, or for the water train for protection from fire. In view of the stifling fumes and gases from the engines in this 40 miles of tunnel, which are very trying to the lungs, it would seem as though in summer some of the roof boards should be removed for ventilation, which is not sufficiently provided for by the gaps between the boards forming the walls. This removal of boards is indeed carried out to some extent, but not enough to ameliorate the certain inconvenience and possible dangers arising from inhaling these fumes. From Summit the train goes coasting down the Pacific slope of the range at high speed, amid magnificent scenery, the descent being almost continuous from Summit (7,017 ft.) to Sacramento (30 ft. above sea level). The distance is 105 miles, and is made in five hours. A few miles east of Sacramento is the junction with the Southern Pacific Ry.'s main transcontinental line (through southern California and Texas), and its line north to Portland, Ore.

The track is laid mainly with 75-lb. rails, having square suspended joints with 24-in. splice bars and pin bolts. Servis tie-plates are very extensively used, many of these being four-flanged plates with four spike holes for double spiking on curves. Redwood ties are used, and some old ones in the Sacramento station appeared to be in very good condition. Across the desert the telegraph poles are square sawed posts, with the insulators attached to the underside of the crossarm. The train of eight cars was hauled by two ten-wheel engines, and it was noted that some of the road engines have a hose reel and fire hose on the top of the rear end of the tender tank, while some of the switch engines have also a fire pump mounted on the boiler. The station at Sacramento is worthy of comment in that it is one of the few large stations provided with a trainshed.

The train now passes through the fertile Sacramento valley, with its extensive fields of grain dotted with numerous groups of fine oak trees. West of the city the line passes over flat swampy grass lands (the "tules"), over which thousands of birds are flying, and then again across more rich agricultural country with quantities of fine trees, the bright fresh green of which is most refreshing to the eyes after days of rocky scenery, desolate hills, barren desert, or even the dark pines of the Sierra Nevada.

At Benicia the railway is cut by the Carquinez Strait, an arm of San Francisco Bay, across which the whole train is ferried on the transfer steamer "Solano." At Port Costa the train again runs ashore, and continues its trip to Oakland, running out upon a pile and rock-filled pier nearly two miles long, in the bay. At the end of the pier is a trainshed and ferry house building 1,050 ft. long over all. The trainshed has a central portion 120 ft. wide and 60 ft. high, and two side portions 60 ft. wide and 40 ft. high, these latter portions being used for the suburban traffic. At the end of the central part of the trainshed is the headhouse building, containing a waiting room 120 × 120 ft., restaurant, offices, etc., and from the waiting room there is access to the upper deck of the large sidewheel ferry steamers running between Oakland and San Francisco.



PIER AND TURNTABLE FOR THIRD AVE. DRAWBRIDGE.

Railway Ferry Steamer "Solano;" Southern Pacific Ry.

This is the largest car ferry steamer ever built. It plies between Benicia and Port Costa, across the Carquinez Strait, 12 miles from San Francisco, the total length of trip being about two miles and

the time less than ten minutes from stop to start of train. The vessel was designed in 1884 by Mr. Arthur Brown, while Superintendent of Bridges and Buildings of the Central Pacific Ry., and it was required that it should have capacity for the longest freight trains on the line. Some idea of its size may be gathered when it is stated that the deck is 424 ft. long and 116 ft. wide, with four tracks having a capacity for 48 freight cars or 24 passenger cars, with locomotives. The hull is of wood, stiffened by four longitudinal Pratt trusses under the deck. It is divided into 12 compartments, and contains the quarters for the officers and crew. There are two vertical engines with walking beams, both placed on the center line of the hull, and each driving one of the side wheels, the shafts being 16 ft. apart c. to c. The engines occupy a superstructure in the middle of the vessel, while the four batteries of boilers (fore and aft of each paddlebox) are in the superstructures erected on the guards, or the overhanging portions of the decks. There are four smokestacks. The steering is effected by four balanced rudders, 11½ × 5½ ft. each, at each end of the boat, the set of rudders at the bow (in either direction) being fixed. The four rudders are coupled together and operated by hydraulic machinery, which, as well as the hand steering gear, is operated from either of the two large pilot houses on the end bridges of the vessel. The engines were built by Harlan & Hollingsworth, of Wilmington, Del. By means of the large rudders and the independent engine to each wheel this great craft can be easily handled in the current, which runs at the rate of eight miles per hour. At either end of the trip the boat runs into a slip formed by guard piles, while an apron 100 ft. long, having five combination bowstring trusses, is adjusted by hydraulic power to fit the level of the deck, being latched to the boat. This apron has four tracks. A full description of this interesting vessel with illustrations may be found in a paper on "The Railway Ferry Steamer 'Solano,'" by Mr. Robert L. Harris, M. Am. Soc. C. E., in the "Transactions of the American Society of Civil Engineers." The leading dimensions of the vessel are as follows:

Length on deck	424 ft. 0 ins.
Length between perpendiculars	406 " 0 "
Beam of hull	64 " 0 "
Width of deck, over guards	116 " 0 "
Draft, light	5 " 0 "
Draft, loaded	6 " 6 "
Height at centre	18 " 5 "
Height at ends	15 " 10 "
Camber of deck	2 " 4 "
Tonnage, registered	3,541 tons
Engines (2)	2,000 HP.
Cylinders (1 to each engine)	5 × 11 ft.
Boilers, number	8
" length	28 ft. 0 ins.
" diameter	7 " 0 "
Tubes, number	143
" diameter	4 ins.
" length	16 ft. 0 ins.
Heating surface, total	19,640 sq. ft.
Grate area, total	288 "
Wheels, diameter	30 ft. 0 ins.
" number of floats	24
" size of floats	17 × 2½ ft.
Apron at slip, size	100 × 44½ ft.
" weight	150 tons

STREET RAILWAY TRUCKS.*

By John N. Akarman.

The term truck, in this case, means the separate framework for holding the running gear of an electric car; namely, the wheels, springs, brakes, motors, etc. When motors were first placed upon street cars, it was believed that there was no necessity for special construction, or any marked departure from the prevailing horse-car practice. The idea of a separate truck was first conceived about 1885, but it was not until the latter part of 1887 that, in its concrete form, it was put into operation.

The first truck consisted of a continuous upper chord made of bar iron in the form of a rectangle. Its purpose was to support the car body, the sills of which rested on its frame. The sides of this upper chord were re-enforced by heavy oak sub-sills to which the chord and the pedestals were both firmly bolted. This form of frame kept the body square and took many of the strains on itself; but it has been abandoned, and in abandoning it and using separate bars, I think we have been drifting away from the best practice, for it had a very important advantage in preserving the squareness of the body and truck. In addition to this upper chord, there was a bar extending around the truck to which the bottom of the boxes were fastened.

Springs over the axle boxes were unsatisfactory, from their stiffness in the limited space available, but by widening the box at the bottom, or adding ears so as to form spring seats, it was found possible to give each box two springs, one on each side, and of ample diameter and length so that they would carry the load with ease and have sufficient motion. Thus placed, they had the advantage of carrying the box perfectly steady, preventing entirely the rocking and unsteady motion. It was soon found that brakes upon electric cars were a very much more important feature than they had been upon horse cars. The brakes were first suspended from the sills of the car, and the sinking of the car body under a load left the shoe so far from the wheels that in applying the brakes, the slack of the chains was increased and could not be taken up without considerable delay. Another difficulty was the longitudinal rocking or pitching of the car body, which is not only excessively unpleasant to passengers, but very destructive to the trucks, motors and track. The lengthening of the wheelbase as a remedy for this did not prove to be of much advantage. The first success as a remedy appears to have been made by extending the sides of the truck, and mounting elliptic or semi-elliptic springs on the ends of the extension pieces. This latter method with the semi-elliptic spring has been the most successful preventative tried.

The composite frame demonstrated its imperfections with the locomotive years ago, and has been found even less successful as a form of construction for a motor truck. This is due in a measure to the fact that on account of cost, first class workmanship is out of the question in building a low-priced truck. The truck frame consisting of a solid forged bar, of course, gives greater strength to resist strains thrown upon it from all directions than any form of a built up truss. I believe the ideal four-wheel truck for electric cars at the present time is the one having the fewest number of parts in its construction, in which the side pieces of the main frame are single forged bars connected across the ends by bars either bolted or welded on so as to make the frame one continuous piece. This frame is carried by springs from the journal boxes, and itself carries an upper chord, likewise, a continuous rectangular piece which has suitable seats for the springs. This upper chord is recessed to take the bolts and spring seats, leaving its upper surface flush. The ends are carried by the half elliptic springs, while the spirals are placed at the journal boxes. The brake should be hung by links. Diagonal bracing is out of the question in the construction of a truck on account of the motors, but the diagonal strength is usually increased by the introduction of transoms. Such a frame carries its machinery with a certainty of its always being in alinement with the driving axle, and as it is spring carried, it is as light on the rails as any form of single truck, while the longitudinal oscillation is prevented by the peculiar effect of the half elliptic springs which do not respond readily to rhythmic motion.

At its best, however, the four-wheel truck is an uncomfortable carriage and a track destroyer, and should only be used where cars are run at comparatively slow speed, and with moderate length of car bodies. Where it is desirable to run at higher rate of speed in suburban service, the damage to the track becomes so great that it should preclude its use. The only alternative is to use a double truck car with swivel or pivoted trucks, and this is easy on curves to a degree that would hardly be credited by those who have only been familiar with four-wheeled cars. The greater number of wheels not only reduces the weight on each wheel, but correspondingly reduces the blow when the wheels strike a joint or a low place in the track. This is still further diminished by equalizing the springs, so that each wheel in rising or falling in passing over any imperfection in track elevates the load a distance but half as great as its own rise. Oscillation, whether longitudinal or transverse, can be completely done away with by the use of double trucks.

The conditions, however, are not altogether in favor of the pivotal truck. As for instance, if all the weight is used for adhesion it is twice as expensive in use as a four-wheel truck. If two motors are used, it only has 50% of the propelling power. In its ordinary form, it makes a wide body necessary and hence is out of place in narrow streets or places where traffic is very heavy. It also has the disadvantage of putting the body at a greater height than is necessary with four wheels.

The "maximum traction" truck may be defined as a pivotal truck in which the load is eccentrically placed in relation to the four wheels of each truck. Two of them receive only a sufficient amount of weight (20%) to keep them upon the track, while the others take the remainder of the load. It was found that it was not necessary to have the wheels of equal size. The large pair used as driving wheels, being very near the pivotal point, have a comparatively small amount of swing, and can be allowed to rise within the floor timbers, while the small wheels moving through a much greater arc easily clear the sills. By this form of construction, the body can not only be brought down, but the frame can be made as narrow as in the ordinary street car body. This form of truck enables the car to be utilized for both street and suburban service. It is also found in its latest form utilized under long open cars. It carries the motors in a satisfactory manner, guides readily and answers nearly all the requirements of the service.

As inter-urban service is almost equivalent to service on steam railways; for this service, pivotal trucks having regular swing beams, equalizers, elliptic springs and all the parts of the steam railway truck are entirely satisfactory. They take curves easily at a high rate of speed. For trucks which must run not only on trams, but T rails, some form of the maximum traction truck will give, all things considered, the best service.

An important question to be considered in connection with the adoption of single and double trucks, is whether the punishment to the track by single trucks is not so great as to more than make up for the cost of putting in and running double trucks under all cars, whether short or long.

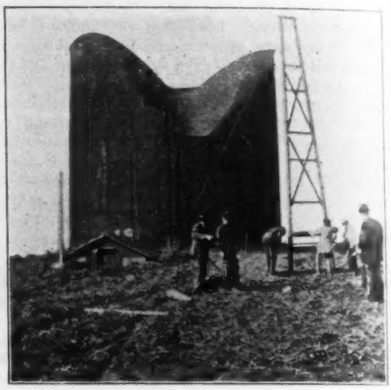
*Abstract of a paper presented at the Annual Convention of the American Street Railway Association at St. Louis.

A WIND-INDENTED STAND-PIPE AT CORTLAND, N. Y.

A partial wreck of a stand-pipe occurred at Cortland, N. Y., on Sept. 29, as shown by the accompanying reproduction of a photograph of the pipe after the accident. The accident seems to point to the necessity, at least in the case of so large a structure, of ample top stiffening.

The stand-pipe is on a hill about 150 ft. high. It is of ½-in. iron for the lower five sheets and ⅜-in. for the remaining distance to the top.

The accident occurred during the night of Sept. 29. A high wind wrecked many roofs in the village of Cortland and blew at an estimated velocity of 80 miles an hour for two hours. The recording gage showed 22 ft. of water in the pipe at the time of the accident, the water extending 2 ft. above the bottom of the bent portion.



View of Partially Wrecked Stand-Pipe; Cortland, N. Y.

Repairs were made by pulling the top back into place, attaching a 4 × 4-in. angle around the top, patching the hole at the break and guying the top by four 1¼-in. steel cables anchored to stone posts.

We are indebted to Mr. Wm. B. Landreth, M. Am. Soc. C. E., of Cortland, for the above information. The photograph from which the view was reproduced was kindly furnished Mr. Landreth by the Cortland Water-Works Co.

THE NEWTOWN CREEK BRIDGE COMPETITION.

(With inset.)

We present to our readers in this issue the designs submitted in the Newtown Creek bridge competition. The engineering problem presented for solution in this case is one of great interest, and one which is likely to come up very frequently for solution in the future. The various designs presented therefore are worth careful study.

Before describing the different designs, however, the principal facts in connection with this much discussed piece of engineering work may be set forth.

Newtown Creek is an arm of the East River which extends from a point about opposite 28th St., New York city, east and south a distance of nearly three miles. It is lined for a large part of its length with docks and wharves and manufacturing establishments, and in consequence a large traffic is continually passing in and out of it. The creek forms the boundary line between Brooklyn and Long Island City, and the Vernon Ave. crossing, only a quarter mile from the mouth of the creek, is the only means of direct communication between these two cities. The next crossing up the creek is on Greenpoint Ave., a mile further up the stream, and there is practically no means of reaching Long Island City

from Brooklyn by this route except by a long detour.

For many years the old wooden bridge, operated by hand power, which has done duty at the Vernon Ave. crossing, has been the subject of severe criticism; and about two years ago, we believe, the U. S. Engineer Officer in charge of the district declared it an obstruction to navigation, and intimated that no center-pier draw-span would be permitted to replace it; some type of movable bridge must be chosen which would give an unobstructed channel the full width of the creek when the bridge was opened.

It may be remarked in passing that the provision of a new bridge at this point has been greatly complicated and without doubt delayed by the fact that Newtown Creek forms the boundary line between Kings County and Queens County, and the joint action of the Boards of Supervisors of the two counties was necessary.

After much discussion of various plans, it was decided to build a bridge similar to the Halsted St. lift bridge in Chicago, designed by Mr. J. A. L. Waddell, M. Am. Soc. C. E., and illustrated in Engineering News of April 19, 1894. The clear span was to be about 140 ft., and the total height of lift about 150 ft.

Bids for constructing the bridge were advertised for, and on July 29 seven proposals were opened. The contract was then awarded to the lowest bidder, the King Bridge Co., of Cleveland, O., at its bid of $418,000.

Subsequently the award of the contract was vetoed by the Supervisor-at-Large, on the ground that the contract price was excessive, being $100,000 more than the estimate made by the county engineer of Queens Co., Mr. John J. McLaughlin, M. Am. Soc. C. E.. Shortly after this, legislation took effect which abolished the organization of Kings county, as it had become coterminous with the city of Brooklyn. The Kings County Board of Supervisors thus ceased to exist and its powers were transferred to the Board of Aldermen of the city of Brooklyn. Joint action of this body and of the Queens County Board of Supervisors thus became necessary to any progress in the matter of the Newtown Creek bridge.

After several months' delay a new scheme was agreed upon, and in July of the present year engineers were invited to submit designs for a bridge on the Vernon Ave. site. A peculiar feature of this competition was that no prizes or compensation of any sort was offered.

Each engineer submitting plans was required to state their price, and was warned that no compensation would be given to any except the one whose designs might be approved and adopted, and he must agree in advance that the entire charge for all his work should not exceed the price submitted with his design. Further, the right to reject any and all designs was reserved.*

On July 23, the designs received by the committee were examined. It was found that eight competitors had submitted plans for a bridge; and one engineering firm which had examined the location and concluded that a tunnel was a preferable solution of the problem submitted a brief advocating that construction.

The designs submitted, with two exceptions, are shown upon our inset sheet. Following the date set for the receipt of designs, plans were also submitted by Mr. Albert H. Scherzer, of Chicago, for a structure similar to the rolling lift-bridge; designed and patented by the late Wm. Scherzer, and in use at Chicago by the Metropolitan Elevated R. R. at its crossing of the Chicago River, and by the City at its Van Buren St. crossing. As this type of bridge was illustrated in our issue of Feb. 21, 1895, and as the design was not presented during the time fixed by the committee, we do not include it on our inset sheet.

After the receipt of the designs, the committee visited Chicago and examined the various types of bridges in use there. As a final result of its investigations it first adopted a resolution approving the bascule type of structure as the most suitable for the conditions existing at the Newtown Creek crossing, and later adopted the plans submitted by Mr. Thos. E. Brown, Jr., M. Am. Soc. C. E., 38 Park Row, New York city.

Turning now to the drawings upon our inset sheet, it should be explained that we have redrawn all the designs to uniform scale and in uniform style from drawings and blue prints kindly furnished by the several competitors. Necessarily, most of our drawings show much less of the details of construction than was shown in some cases on the designs submitted to the committee; but we have endeavored in every case to show enough detail to make clear the important features of the design.

Fig. 1 shows the design submitted by Mr. Brown. It is a hinged-lift structure in two halves, supported by towers on each shore and operated by hydraulic power. More in letail the design is described by Mr. Brown, as follows:

"The bridge consists of two hinged spans 80 ft. 4 ins. long from center of hinge to center of river, or a total of 176 ft. 8 ins. between hinges, and two towers about 74 ft. high, surmounted by houses for the operators.

The outer ends of each span will rest on steel trestle bents, hinged to the lower chords of the trusses. These will rest on castings in a sub-pier at bottom of river. The trestle bents will rise with the bridge and fold parallel to the floor of the spans, leaving the full depth and 150 ft. width of stream clear of obstruction. This motion will be controlled by a positive automatic connection, independently of the weight of the bents.

Small hydraulic pressure pipes will be laid, as indicated, to the central sub-pier. Any silt drifting under the feet may be washed away by turning pressure on these pipes. The bents may be dispensed with if preferred, and the span supported by suspenders from the towers, as indicated on the plans.* This will increase the cost of the bridge.

Each span will be balanced by two cast-iron weights in steel frames running in guides in the frame work of the towers. These will be connected with the span by 12 1½-in. steel cables (six on each side), passing over two 10-ft. diameter steel riveted wheels, placed on top of the tower. The weights will be subdivided and the cables attached to them by equalizers with adjustable connections.

The cables will be connected to the spans by a system of links, so arranged that the counterweight, though constant, will balance the span in all positions, except near each end of the travel, where the position of the links is such as to cause the weight to act against the moving span and assist in bringing it to rest. This arrangement is shown by an explanatory diagram on the drawings.

On the ends of the spans are placed curved lattice buffers which will engage the cables should the spans pass the perpendicular line. These are so arranged that a wind pressure of over 30 lbs. per sq. ft. will not be sufficient to force spans against towers.

Each span will be operated by eight hydraulic rams, 12 ins. in diameter and about 8 ft. stroke, four for lifting and four for lowering. These will be supplied with pressure from a compound duplex pump. An additional duplex pump is provided to act as a relief for the compound pump and to increase the working pressure during high longitudinal winds. These will be automatically controlled by variable power hydraulic valves.

All hydraulic pipes, fittings and cylinders will be tested to 2,500 lbs. per sq. in., and will be so duplicated that the bridge will be capable of operation in the event of disabling of any two of either set of four rams or their connections. The rams are of sufficient size and strength to resist a longitudinal wind pressure of 30 lbs. per sq. ft. on the entire floor of the bridge. The arrangement of pumps is such that a range of hydraulic pressures may be obtained up to 1,200 lbs. per sq. in. Under average conditions the working pressure will be about 250 lbs. per sq. in. Mechanical automatic stops will be provided in connection with the operating valves, which will bring the bridge to rest gradually at the end of its travel. Hydraulic buffers will also be provided on the ends of the rams, for the same purpose, as an additional safeguard.

Hydraulic speed governors will be provided, by means of which the speed of the bridge will be controlled or limited independently of the operator. The operator may move the bridge as slowly as he may desire or stop it entirely at any point of its travel, but he cannot, nor can a puff of wind, increase the speed beyond the limit at which the governors are set.

The bridge may be operated in calm weather in 30 seconds and closed in the same length of time. Under average conditions the time would be about 45 seconds opening and 45 seconds in closing. The bridge may be operated directly by a man in the tower, or by signal bell to a man in the engine room, as may be preferred.

The plan includes suitable boiler and appurtenances, and the entire power apparatus is located in the foundations of the tower. If a supply of electric current is available, electric motors may be substituted for hydraulic rams and the boiler be dispensed with. We prefer a hydraulic plant for this class of work, considering it more reliable and certain in action, and less liable to derangement."

Fig. 2 shows a half-span of a structure designed by Mr. W. H. Breithaupt, M. Am. Soc. C. E, 71 Broadway, New York City. It is a three-hinged arch, made in halves, with the bridge floor suspended from it and hinged to it. The following is from the description submitted by Mr. Breithaupt with his design:

The floor is in two parts and is hinged to the arch near its ends. The arch is made to part at the center point, and each half is arranged to revolve around its endpins. There are two towers, one at each end of the arch. Over the tops of the towers, and attached to the two halves of the arch at the center joint, are cables, by means of which the mid-stream ends of the floor and arch halves respectively are raised. The floor suspenders are stiffened pairs of eyebars, jointed at the center of their length so as to fold between the floor and the arch as the floor is raised. In opening the bridge the floor halves are first pulled up against the arch; then the arch parts, with the floor parts close against them,are raised to approach a vertical position against the towers. In many cases, such as to allow passage of single tugs or barges having no high projections, it will be necessary to raise the floor parts only, without disturbing the arch. When the bridge is open the roadway from either side is shut off by the bridge floor standing on end across it, and forming an effective barrier.

There are two sets of counterweights, one for the floor, and a main set for the entire bridge. The floor counterweights are of constant counterbalance, consist of a single weight each, and operate, with the exception of a short-leverage pull afterwards, only in raising the floor against the arch. The main counterweights consist each of a chain of weights, suspended from the respective cables, and having its lower end attached to a fixed point. As the counterweight descends it gradually reverses and its weight is gradually and evenly, without shock of any kind, transferred to hang from the fixed point spoken of. This arrangement provides for uniform conuterbalance as the arch parts rise.

The bridge is operated by means of electric motors, one in each tower, connected by a cable under water, and controlled from one switch by a single operator. The mechanism is so arranged that the two arms of the bridge move together and that one cannot get ahead of the other. The motors connect to the drum shafts by means of worm gearing, as an additional safeguard in regulating the movement of the bridge arms. The motive power may also be a steam engine in each tower, electrically controlled to operate synchronously. A hand winding arrangement is provided at each worm shaft, so that the bridge can be operated by hand power, in the very improbable case of this being necessary.

The floor can be raised to the arch in less than 20 seconds and the full raising of the bridge can be done in 40 seconds. No locking of any kind is required, on closing, and therefore no time is taken up in this way.

Forming the center joint of the arch, one arm has a convex end and the other a corresponding cavity with guide projections, which serve to bring the two arms to their proper bearings against each other. The surface of contact between the arms is, in vertical section, a little less than a vertical semi-circle, a slight revolution of one end about the other being provided for. This allows for expansion and contraction of the arch arms, without disarrangement of any part. To avoid shock on the coming together of the two arms, hydraulic buffers are interposed at the tops of the towers to check the main counterweights as they come to their upper limit of travel. Buffers are also placed at the points where the floor impinges against the arch, during the raising of the bridge.

Mr. Chas. E. Bedell, 156 Fifth Ave., New York city, submitted a design which is shown by Fig. 3. It is of the bascule type, and the outer ends of

*See Engineering News, July 9, 1896, pp. 24 and 26.

*By an error in our drafting department the dotted lines showing these suspenders were omitted from Mr. Brown's design.—Ed.

the two folding arms are supported by eye-bars from the towers. An important feature of the design is the support of the towers on cylindrical piers and the provision of a rear anchorage for the tower to a masonry abutment on the shore to take up the pull of the suspenders that carry the channel span. In order to vary the pull of the counterweight with the varying positions of the channel span, each counterweight will consist of a number of separate plates of cast-iron arranged to be supported on small brackets at intervals of about 2 ft. vertically in the height of the tower and to be picked up in succession as the counterweight ascends, or deposited as it descends. This is practically the same device that was used in the temporary drawbridge of the New York Central R. R. over the Harlem River.

The bridge is to be operated preferably by a 50-HP. electric motor, in each tower, and 40 seconds is given as the time necessary to raise or lower the bridge. The dimensions proposed are a clear span of 150 ft.; lift-arms, 96 ft. each; fixed spans, 50 ft. each; height of towers, 112 ft. Travel of counterweight, 95 ft.; cross-section of counterweight well, 4 × 8 ft.

It will be seen that the eye-bar suspenders are attached to the channel spans at a point ⅓ of their length from the outer end and make an angle of 45° with the towers. They have a pin joint at the center permitting them to fold as the bridge is raised by the cable.

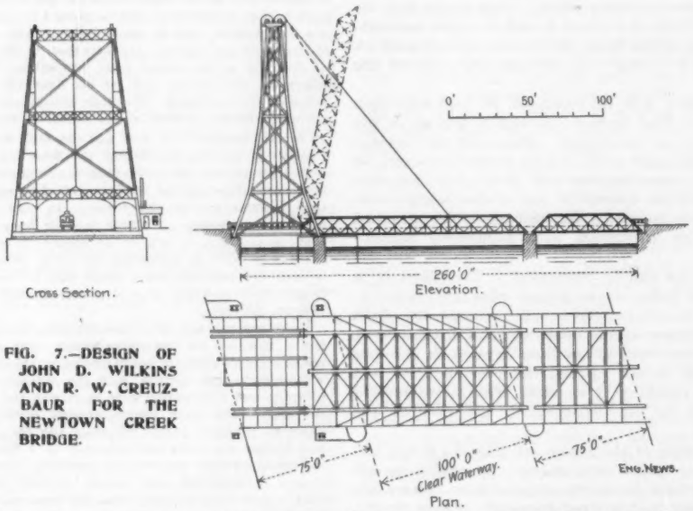


FIG. 7.—DESIGN OF JOHN D. WILKINS AND R. W. CREUZBAUR FOR THE NEWTOWN CREEK BRIDGE.

To operate the structure an attendant is required in the motor-house in each tower. Folding gates to close the sidewalks and roadway and operated from the motor-house are provided at each tower.

The design submitted by Mr. E. B. Jennings, 170 Florida St., Springfield, Mass., is shown in Fig. 4. It is also of the bascule type, but dispenses with towers, and a truss is used instead of a girder for the span. When the bridge is closed the top chords of the two halves simply butt against each other, but the bottom chord is made continuous by a pin joint. We quote as follows from the description furnished to us by Mr. Jennings:

To open the bridge it is only necessary to withdraw this pin, when by means of suitable machinery at each end the bridge revolves vertically on the pivots and the channel is left entirely free for navigation.

The ends are counterbalanced, and the gearing used may be similar to that of an ordinary horizontal swing bridge.

At the center of the top chord there is a V-shaped projection at one end, and a corresponding depression at the other end serving to bring the bridge into proper position when closed. The eye-bars at the center of the bottom chord are placed an inch or two apart so that they may more easily come into place when the bridge is closed. The pin at the center of the bottom chord is made cone-shaped and the chord bars are bored to fit, thus allowing the pin to be more easily moved in and out.

If the motive power is steam, the engine, boiler, etc., may be placed under the roadway, or electric motors may be used if preferred.

Two subways are suggested to accommodate foot passengers while the bridge is open.

The design submitted by Messrs. F. S. Williamson, M. Am. Soc. C. E., and Alfred Liebmann, 50 Broadway, New York city, is for a lift bridge (Fig. 5), resembling in its general construction Mr. Waddell's Halsted St. lift bridge at Chicago. The chief difference is that these designers have curved the rear leg of the tower and have arranged to have the span raised and stopped at a level of about 30 ft. above low water to permit the passage of tugs, scows, etc., and still permit foot passengers (but not vehicles) to cross the bridge. Further, these designers propose to use gates to automatically close the roadway at each tower when the bridge is raised.

We have been favored by the designers with the following interesting discussion of the elements involved in the problem and the reasons for their selection of the design which they submitted:

The Bridge Committee of Kings and Queens counties, having invited designs for this bridge at Vernon Ave., we commenced the study of the problem by at once visiting the site and seeing for ourselves the conditions we had to meet.

We found in the first place that the majority of the people of Long Island City were in favor of a high level bridge, and that they had so publicly expressed themselves on more than one occasion. Also that this view of the case had been held and advocated by the "Brooklyn Eagle" for a long time past. The approach on the Long Island City site is crossed by no fewer than six tracks of the Long Island R. R., a most dangerous crossing, and it is not to be wondered at that the people using this bridge should advocate a raised approach thereto.

We next found that the railway company was prepared to co-operate with the city in the building of a viaduct in connection with such a high level bridge, and moreover would surrender a portion of its yard for this purpose if required for a more gradual descent to the street level.

The abolition of this dangerous grade crossing would be only in the line of the vast improvements going on in almost every large city of the country, at great cost to all concerned.

The roadway of the bridge, if this plan were carried out, would cross the creek at such a height that all mastless vessels could pass under it, thus allowing the passage of seven-eighths of all the water traffic at this point. This is a matter not only affecting the owners of tugs and barges, and the shippers and manufacturers doing business along the banks of the creek, but the thousands of pedestrians and wagons crossing the bridge.

The writers on one occasion stood at the entrance of the bridge for 15 minutes and in that time the bridge was opened no fewer than three times, and the gates at the railway crossing, not 300 ft. away, closed four times. The obstruction to street traffic was as serious as it was confusing, dozens of teams being hemmed in between the gates on the one hand and the open draw on the other. Now, if a bridge should be built which would allow seven-eighths of the water traffic uninterrupted passage, while permitting a free crossing for the thousands of pedestrians, a great part of the problem would be solved.

It was feared, however, that the opposition of the property-owners would result in legal complications and long delays. The decision was therefore arrived at to abandon this part of the plan, owing to the urgent call for the new bridge at this point. Nevertheless the probability of this high level approach being called for at no very distant date, led us to believe that the bridge must be of such a character that it could be converted cheaply and expeditiously to meet this eventuality.

Now that we were obliged by force of circumstances to give up the idea of a high level structure, the importance of having to close the bridge as seldom as possible to the very large number of foot passengers using this bridge, became evident. These passengers at certain times of the day are largely work people, going to or coming from their work, whose crossing should be obstructed as little as possible. This would be impossible if the bridge had to be lifted every few minutes for the passage of every tugboat or float.

We think that our design offers a solution of the two important points herein enumerated; first, the inexpensive and ready manner in which the lift bridge can be changed to suit the future construction of a high level approach; and second, the importance of being able to raise the bridge to such a height as to admit of the passage of mastless vessels without interrupting the crossing of the large number of foot passengers.

The illustration on our inset sheet shows the construction which these engineers propose for the present. It will be evident that by merely placing column supports of proper height at the towers the bridge would become a high level structure whenever the necessary viaduct approaches may be built. The estimate of cost submitted by Messrs. Williamson & Liebmann was as follows:

Steel in superstructure, 1,200,000 lbs, at 4 cts.	$51,000
Lumber in floors, 60,000 ft. B. M., at $30.	1,800
Operating machines, cables, weights, etc.	72,000
Substructure	74,000
Total	$200,000

A peculiar design, submitted by Mr. Chas. Steiner, 403 Bushwick Ave., Brooklyn, is shown in Fig. 6. It is a hinged lift span in two halves. Each half consists essentially of a principal compression member which is stiffened by trussing, as shown. When the bridge is closed these two compression members abut against each other and their thrust is transmitted to the abutments on each side. To raise and lower the leaves a segmental-shaped chamber is built on each abutment and a rectangular piston attached to and forming part of the bridge truss is moved to and from in this chamber by water, "at a head of 100 to 200 ft." Sketches were submitted, which we do not reproduce, showing a method of making this rectangular piston and the chamber in which it moves water tight, and "spray-guards of light plates protect waiting passengers from occasional escape of water."

Messrs. John D. Wilkins, 51 State St., Albany, N. Y., and R. W. Creuzbaur, Assoc. M. Am. Soc. C. E., submitted a design of which we received a drawing too late to include it on our inset sheet. It is, therefore, shown herewith (Fig. 7), while Fig. 8 shows a detail of the counterweighting system employed, which is the principal feature for which claims are made in this design. It will be seen by the drawing that the counterbalance, or a part of it, is in the form of a heavy chain, as in the design submitted by Mr. Breithaupt, but one end of this chain is attached to a cable passing over the pulley at the top of the tower instead of being attached to a fixed point as in Mr. Breithaupt's design. We quote as follows from the description submitted with the drawings:

The movable part of the proposed bridge is a hinge bridge, firmly hinged at one end and lifted by means of steel cables to nearly a vertical position, to give a clear way for the passage of vessels.

The bridge is designed with the Wilkins improved counter-balance, which has no loose parts, is noiseless in its operation and counterbalances the bridge with the greatest precision in any position it can take. Being so nicely balanced, it requires the least amount of power to operate the bridge, and on account of the steady motion of all the moving parts the bridge can be opened or closed with the greatest rapidity.

A balanced-hinge bridge in motion requires a continually changing counterweight. In the original hinged bridge this change of counterweight was effected by releasing parts of the counterweight at intervals during the raising of the bridge, and in picking them up again during the lowering of the bridge. Only a rough approximation of the true counterbalance can be made in this way. The continuous releasing and picking up of heavy pieces of cast iron occasions severe blows, and requires powerful engines and a heavy tower. The motion of such a bridge must be slow to avoid destruction of machinery and structure. The Harlem River hinge bridge was built on this plan; it has to be operated slowly, but otherwise it works very satisfactorily.

The Wilkins system provides for a continuous change of counterweight by connecting the separate parts of the weight in the form of an endless chain. A perfect counterbalance may be obtained in this way, the motion is steady,

without shocks and vibrations, therefore the maximum of speed is attainable. It is the simplest device of a changeable counterbalance known; it has no loose parts, is almost without friction, and it cannot get out of order. In addition to perfect balance and speed of operation, the Wilkins system of counterbalancing a hinged bridge requires less than half the power required for a vertical lift bridge, only one tower and no other substructure besides the bridge. It requires less machinery than any other kind of movable bridge. The operating engine occupies a space of about 6 × 8 ft.; besides this there are no other parts of machinery, no gear wheels, no shafting, no part of the structure or machinery is below high-water mark, and every part is easily accessible. The greatest care has been taken to select and combine only such devices as will insure immunity from repairs. All parts of the machinery and the wire ropes are arranged so that they can be replaced if worn out without interrupting for a minute the operation of the bridge.

The bulk of the counterweight is in stone ballast, contained in a box made of steel plates and angles. If at any

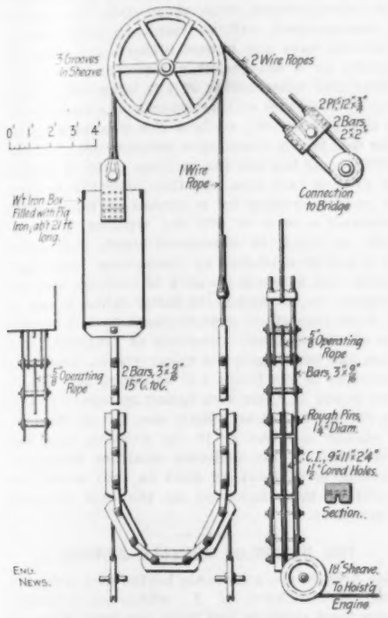


Fig. 8.—Details of Wilkens' Counterweight System for Bascule Bridges.

time it is desired to put a heavier floor on the bridge, practically perfect counterbalance can be restored by adding more stone and adjusting the chains.

With this description an argument was also submitted respecting the advantage arising from quick opening in a swing bridge and from economy in operation. We reproduce it as follows:

The difference in time of opening does not represent the total amount of time gained. A bridge-keeper finds it much more difficult to estimate the distance a vessel can cover in three minutes than in one. Therefore, in the latter case the vessel is far more likely to be ready to enter the channel as soon as opened; whereas, with a slow-opening bridge, the vessel is apt to be a distance off after the passage for it is clear.

The gain of only two minutes semi-hourly during fifteen hours—a moderate estimate—amounts to a saving of one hour; an hour taken daily from a busy community complaining of the loss of every minute. Estimate the loss of time to all the waiting vehicles and pedestrians at only $20 per day, shows that a bridge which saves such time is worth to the city, at 5% interest, $120,000 more than any other bridge that does not save such time, every other qualification being the same. * * * *

A saving of $10 a day in operating a bridge increases its value at 5% by $60,000.

Messrs. Wm. W. Crehore, Assoc. M. Am. Soc. C. E., and Frank Miller, C. E., Havemeyer Building, New York city, submitted to the committee a design for a tunnel with an argument in its favor. We omit the design, but present the substance of the description submitted to the committee as follows:

The chief objection always raised, whenever a tunnel has been proposed at this site, is the expense consequent upon having to reach back on either side of the Creek far enough to avoid impracticable grades. The accompanying plans have been prepared with the idea of reducing this item of expense to a minimum.

Beginning at the intersection of 3d St. and Vernon Ave., in Long Island City, it is proposed to depress the middle of Vernon Ave. (for a width of 30 ft.) to a grade of 10%. for a distance of one block or to the north side of Ferry St., at which point the covered tunnel would begin. This opening in the street will, of course, be fenced in and the street curb will be moved back about 5 ft. on each side of the street to permit vehicles to pass along beside the opening. Thence passing under Ferry St. and the Long Island Ry. tracks with a grade of 5.3%, to a point 37½ ft. beyond the bulkhead line on the Long Island City side, the tunnel will have reached its lowest point. The War Department's requirement for a channel is 125 ft. wide and 18 ft. deep at low water. The proposed tunnel is level for a distance of 125 ft. in midstream and at such a depth that its highest point is 7 ft. below the War Department requirement above mentioned. Thence on the Williamsburgh side the ascending grade will be 6.7 ft. in 100 to Commercial St., whence a 10% grade continues to the surface of the ground one block away.

It is proposed that the main section of the tunnel shall be composed of a steel frame and concrete arches 2½ ft. thick, so constructed as to be impervious to water. The clear height at the centre will be 14 ft. and the clear width 32 ft., which provides for a 20-ft. roadway and two 6-ft. sidewalks. An efficient system of drainage, including a small pumping plant, will be supplied. On the 10% grades at each end of the tunnel, the roadway will be widened to 32 ft., the sidewalk being discontinued before reaching this grade by providing stairways on either side for pedestrians. By increasing the width of roadway on these grades and by placing the car tracks at one side, a suitable track of inverted steel channel bars could be provided on the other side of heavily loaded vehicles going up. Vehicles entering the tunnel are to follow the entering car track, while those leaving may select either the up car track or the track especially prepared for them. This method will facilitate travel on the steepest part of the road and prevent delays. It is also proposed to provide an endless cable on this 10% grade, moving slowly at any desired velocity along the side of the wall about 3 or 4 ft. above the tunnel roadway, having rings at short intervals so that teams which need assistance in ascending the grade at the mouth of the tunnel may carry a hook and line to catch in one of these rings.

Pedestrians will enter and leave the tunnel by easy flights of stairs located between Ferry St. and the Long Island Ry. tracks on the Long Island City side; and just north of Ash St. on the Williamsburgh side. These stairways will be 10 ft. wide to a platform about one-third the distance up and then shall divide in two stairways, each 5 ft. wide, leading in opposite directions. Two such flights of stairs will be placed at each entarnce to the tunnel, one on each side, as shown on plans. The capacity, roughly estimated, would be 15,000 to 20,000 pedestrians per hour in each direction.

Method of Construction and General Cost.—There are several methods of constructing tunnels in soil which is of the nature of this soil and it would be a matter for contractors to figure on as to which method might be the cheapest and best. In proposing a steel frame and concrete arch lining for the tunnel, we considered that the coffer-dam method of construction would be the cheapest and that it would be possible to use it throughout the length of the tunnel. It would only be necessary to keep open a portion of the route at a time, and in view of the fact that the traffic would have to be turned aside on a temporary bridge, in any case, this should not be a serious objection. The cost of excavating, constructing the tunnel, and back-filling, including all contingencies, such as the removing of the old bridge pier on the river and setting up the old bridge as a temporary affair further up stream, we estimate would be in the neighborhood of $450,000.

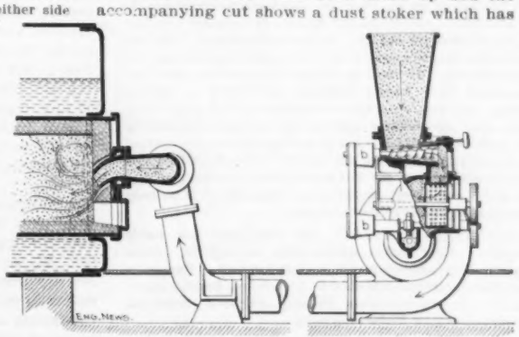
Advantages of a Tunnel.—The item of time saved to teams, pedestrians and street car traffic as well as to the traffic in the river itself, is something that cannot be accurately estimated, but can readily be imagined. With a tunnel instead of a bridge, the cost of maintenance would be reduced practically to nothing, and a continual stream of travel may be kept up in either direction, both on land and in the river. The one item of the cost of seven men (four by day and three by night) to attend the present drawbridge is worth, if capitalized at 4%, about $75,000. Practically the only running expense in connection with the tunnel would be a small pumping engine and one man to tend it.

Any proposition to cross the river by a bridge at this point, which does not include a viaduct approach on the Long Island City side, leaves half the problem unsolved, inasmuch as the delay to traffic by crossing the Long Island Railroad tracks at grade is fully equal to any delay due to a drawbridge or lift bridge. The present proposition is to cross these railroad tracks below grade, and in addition to the saving of time thus made there is the advantage of absolute security from any accident from railroad traffic. This advantage accrues to the railroad company, as well as to the municipal government, inasmuch as they are practically secured against suit for damages due to accidents or loss of life. The railway people will also be relieved from the running expense of guarding this crossing. It seems to us in view of the advances being made in other states in the matter of abolishing grade crossings, that the time is not far distant when some legislation will be taken by the State of New York to compel the abolition of all grade crossings of whatsoever nature. In such an event, either a tunnel must be constructed similar to the proposed design, or a problem of much greater magnitude will present itself for solution. In either event any bridge across Newtown Creek at the level indicated by the present lay of the land would have to be abandoned.

In addition to the advantages already enumerated, the adoption of the tunnel will provide much greater dock front on both sides of the river at the points now used for the bridge approaches.

A GERMAN COAL DUST STOKER.

The burning of coal dust was taken up in this country a dozen years or more ago with a view to utilizing the culm or waste products of the anthracite mines in this way. Since it is now found possible to burn the culm as it comes from the breakers without further crushing or grinding, nothing has been done, we believe, toward the development of dust fuel burning. In Germany, however, the matter has been taken up and the accompanying cut shows a dust stoker which has been in successful use in Berlin for 18 months. The construction is evident from the drawing. The coal is ground in a mill and carried to the hopper of the stoker by a traveling conveyor. The rate of feed of the dust is regulated by a slide in the bottom of the hopper and also by the cone pulleys b b, which drive the feeding worm. The amount of air blown into the furnace with the dust is also regulated by a slide in the fan.



A STOKER FOR FIRING COAL DUST.
F. de Camp, Inventor, Berlin, Germany.

The apparatus is the invention of F. De Camp. The boiler which is working in Berlin is said to have shown the system to be durable and to require few repairs. The boiler flues are cleaned once or twice a day. The advantages claimed for the system are that it is an automatic stoker and forced draft combined; that combustion is complete and smokeless, even when the poorest grade of fuel is used; and that the system gives a high evaporative efficiency and is economical in operation. It will be noted that it has the advantage over automatic stokers of the ordinary type that no machinery is exposed to the fire.

THE COMMERCIAL UNION OF SAXONY, says U. S. Consul Monaghan, of Chemnitz, has issued its tenth annual report showing the progress made in building up a foreign trade. In this ten years the Union has sent out, at a total expense of $75,000, seven traveling commissioners to investigate trade prospects in Canada, Mexico, the West Indies, South America, Eastern Asia and South and East Africa. It has also circulated German and English catalogues, circulars and reference books in five languages, calling attention to the industries of Saxony. Since 1885 8,000 merchants have visited the sample rooms and 9,000 answers have been sent out regarding the standing of foreign firms. Sample orders to the extent of 13,000, and covering $1,750,000, were sent out and these secured business valued at $7,500,000 more. The union has 46 agencies in Europe and 53 beyond the seas, with a home membership of 504 business houses. This union is only one of a number in Germany, and Mr. Monaghan says that the 3,500,000 people of Saxony are "busy as bees" turning out all manner of products for the English, French and American markets. This ten years of Saxon experience should be studied and followed by American producers. Export organizations already in existence in New York and in Philadelphia will tell them how to profit by it.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

In the Supreme Court of Kings County, Mr. John Ireland is held personally responsible for the construction of his building which collapsed in this city, a year ago, and the jury returns a verdict of $10,000 against him for the loss of the life of one Burke in the suit brought by his mother. While this suit was also instituted against the two contractors, these latter were exonerated by the jury, which held that the construction was under the personal supervision of the architect, the direct agent of Mr. Ireland. While this finding will probably be contested, the tendency of similar awards would be to impose greater responsibility upon the owners of real estate, and to lead them to be more careful, both in the selection of their architects and their contractors. The lowest professional fee combined with the lowest bid for work to be performed would no longer be a safe standard for acceptance on the part of the owner and actual builder.

The censure of Chief Engineer W. S. Moore, U. S. N., for the late grounding of the battle-ship "Texas" in Newport Harbor, carries with it a lesson not made sufficiently plain in the official finding of the board of inquiry. And that is that the whole accident was due to the lack of a sufficient number of trained steam engineers on board this important vessel, and that as a consequence both port and starboard engines at the time of the accident were in the temporary charge of unskilled and irresponsible men, one a naval cadet and the other the chief machinist. It is true that a remarkable chain of circumstances preceded the accident that could not have been foreseen. The dynamo broke down and put out the lights in the engine-room just as the ship was entering the harbor; this accident made it necessary for the Passed Assistant Engineer in charge of the starboard engine to leave his engine in the temporary care of a naval cadet. When the signal came to reverse the engines, the starboard engine stuck and the Assistant Engineer in charge of the port engine left his post to assist the naval cadet in handling the reversing gear; the chief machinist put in temporary charge of the port engine, meanwhile, failed to observe the working of the mechanical telegraph which was used in place of the disabled electric telegraph, and he kept his engine going ahead while reporting that he understood the signal given from the bridge. The Chief Engineer was at his post, but he could not see the indicator dials and know that the signals were being misinterpreted. The court ascribes the grounding to a combination of these causes and censures the engineers, while very properly exonerating from all blame the captain of the ship. The accident is a telling commentary upon the attempt of certain naval officers, not engineers themselves, to still further reduce the engineering staff, and to put the actual working of the costly machinery of our war vessels into the hands of machinists and other subordinates of no authority and limited training. With the proper officers at their proper posts the signals given from the bridge of the "Texas" would most probably have been obeyed and the grounding would not have occurred. But, by reason of two engineers having to attempt to do four men's work, both engines were temporarily left in the hands of men who blundered; for no particular cause other than that they were not equipped for the work entrusted to them. The accident is a further illustration of the fact that in handling modern warships plenty of well trained engineers are an absolute essential; and that the number on board each ship should be such that no emergency can call from his post the engineer in direct charge of any engine. It never pays, even in the United States Navy, to set a boy to do a man's work; though some officers think that this can be done with safety.

A correspondent believes that we have been somewhat too sweeping in our note of timber and pile graving docks, as expressed in our issue of Oct. 22, and he questions the existence of timber dry-docks in England at all. Our chief arguments in favor of timber for this purpose were the cheapness of such docks as compared with either stone or concrete, their roomy proportions, which better facilitated work within them, their quick construction, and the fact that they could be protected against the marine worm, and against decay in the upper works, by a judicious use of concrete. There is one qualification, however, which we omitted, and that was in the location of the docks. In our country it is altogether probable that in the warm waters and damp weather of the South, a timber dock will decay faster than in the North (and the point may possibly be reached where the stone or concrete will be preferable). In the North, the stone dock is subjected to the attacks of frost, and this mischievous agency does necessitate, more or less, frequent and costly repairs, and the timber dock is, as a consequence preferable.

Our statement above referred to contained a misprint as to the time occupied in the construction of the Puget Sound dry-dock. The original contract of Oct. 29, 1892, called for completion in 36 months; but a supplemental contract was made, on Dec. 10, 1892, for lengthening the dock 50 ft., with an extension of time amounting to 3½ months, or 39½ months in all. But notwithstanding the added work the dock was finished in about 33 months; not 43 as printed. The timber dry-dock at St. Johns, Newfoundland, was completed in 13 working months; the timber dock at Norfolk was built in 21 months and the Newport News and the League Island docks each in 24 months. As to the actual experience with timber dry-docks in the United States, it may be stated that the oldest Simpson dry-dock was built at East Boston, and finished in November, 1854; another was constructed there in 1855, and a third in 1864. These docks are practically in good condition at the present day. The two timber docks at Portland, Me., were built in 1868-70. Concerning the use of timber for dry-dock construction in England, our correspondent is referred to a valuable chart on the "Dry Docks of the Thames," issued in 1882, by Mr. Charles James Jordon, M. I. N. A. This chart, in book form, covers all the dry-docks on the Thames, at that date, 41 in all. Of this total, in 1882, 6 were all wood, only 7 were all masonry, and 28 were partly of wood. Unfortunately the date of construction is not given for these several docks, but the fact that some of the all-wood docks are of small dimensions, and are closed by the old-fashioned wooden gates would point to a very early construction. These wooden docks, however, are unlike the type now built in this country, being unprovided with altars, or steps, and having vertical side walls of timber. Some of them have wooden bottoms and wooden gates with brick side walls. The important fact, however, is that timber has long been used for this purpose in England, and that many of these timber docks were still in use upon the Thames a comparatively short time ago.

The results of the tests of the Roebling system of fireproof construction, in which a concrete arch, strengthened with steel rods, constitutes the floor support, will, we think, be a surprise to those who have not known hitherto the value of concrete as a fire-resisting material. That an arch of this construction of 4 ft. span, only 3 ins. thick in the center, could support a floor loaded with 150 lbs. per sq. ft., while a fire was kept under it for five hours, reaching a temperature of above 2,300° F., or beyond the melting point of copper and even of cast-iron, and then after this heating and sudden cooling by a stream of water could withstand a load of 600 lbs. without fracture, would, we think, be considered highly improbable had it not been proved by these tests. The competitive test between an arch of concrete and one of hollow tile, in which the latter failed, is one of the most important contributions to our knowledge of the ultimate resistance of fireproof floors which has been made for many years. The manufacturers of tile floors will no doubt have something to say in their own behalf in regard to this test, for it was not an official one, but as the matter stands it looks as if the concrete men had shown that in fire-resisting qualities their construction is at least as good as that which has heretofore been accepted as the best standard construction.

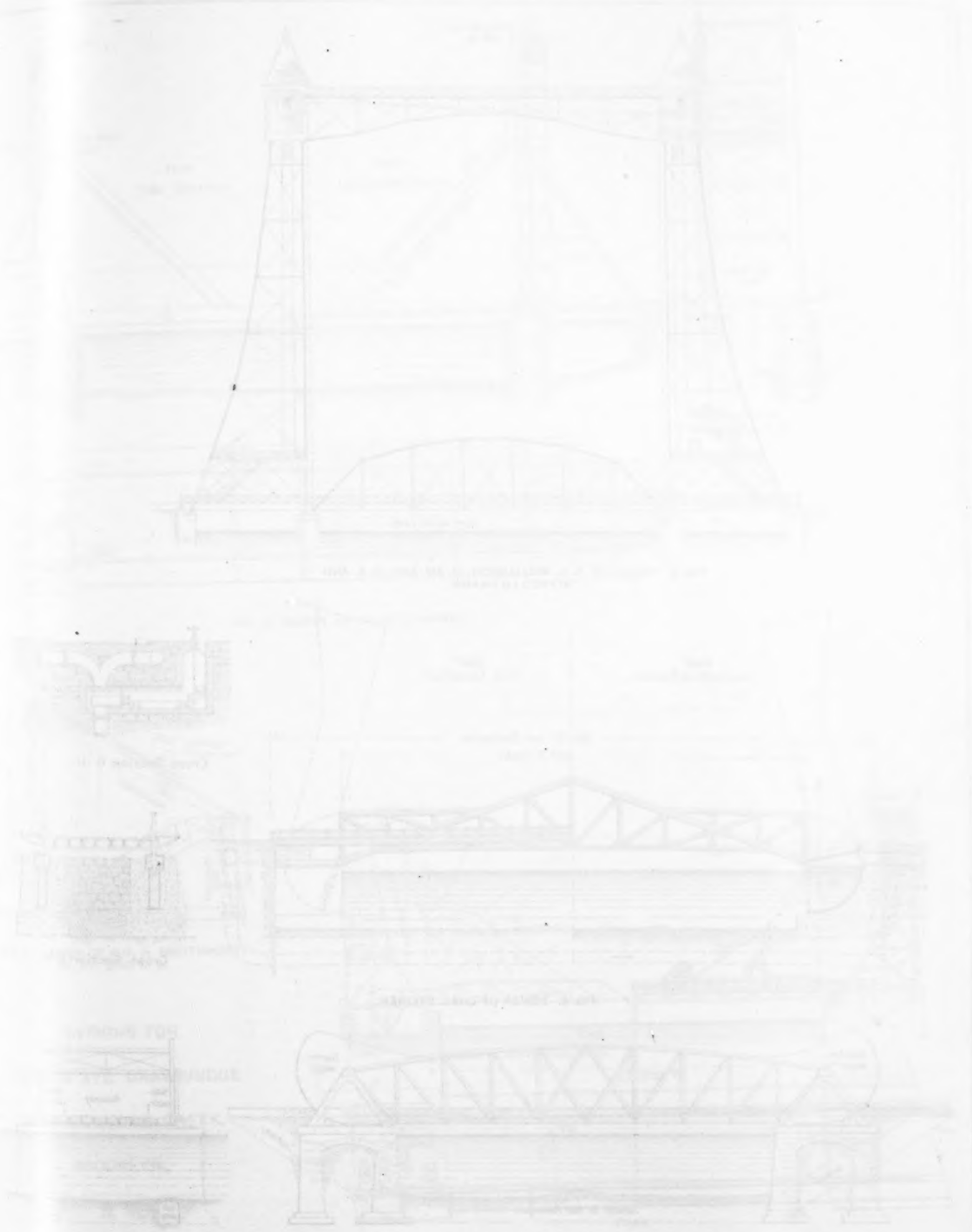
THE DESIGN OF MOVABLE BRIDGES.

The designs for a movable bridge over Newtown Creek, at Brooklyn, N. Y., which are presented on our inset sheet in this issue, are interesting not only as respects the solution of the problem presented in this especial case, but as evidence of departures in the construction of movable bridges from the long-time standard swing span, which deserve the careful attention of engineers.

It is true in engineering work as in every other industry, that the force of precedent and custom is exceedingly powerful, and often leads to the adoption of a certain pattern or type of structure or machine, not because it is the best that could be devised or that is offered, but because custom has sanctioned it, and anything else is an innovation. In the especial case before us it has come to pass that the swing bridge is accepted without question as the proper means of carrying a road over a navigable waterway. Only within the past dozen years have any notable instances been furnished of exceptions to this general rule.

It is of interest to trace the process by which the swing bridge came to be the standard type of construction. The original drawbridge was not a swing bridge at all, but a lift bridge. In the centuries preceding the modern era, practically the only place where movable bridges were used was in crossing the moat that surrounded a castle or fortress. For this purpose a simple floor, hinged to a tower on the inner side of the moat and drawn up to a vertical position when the bridge was opened, was the type of structure in general use. The floor of the bridge when opened was an admirable barrier against enemies who might succeed in crossing the moat. The under-side of the bridge was sometimes covered with iron to prevent an attacking party from cutting it away.

Of course the openings which all such spans covered were of trivial width. Not until the art of building timber trusses was developed was it possible to bridge any stream of considerable breadth with a fixed span even, much less a movable one. With the advent of timber trusses, however, it for the first time became possible to throw structures



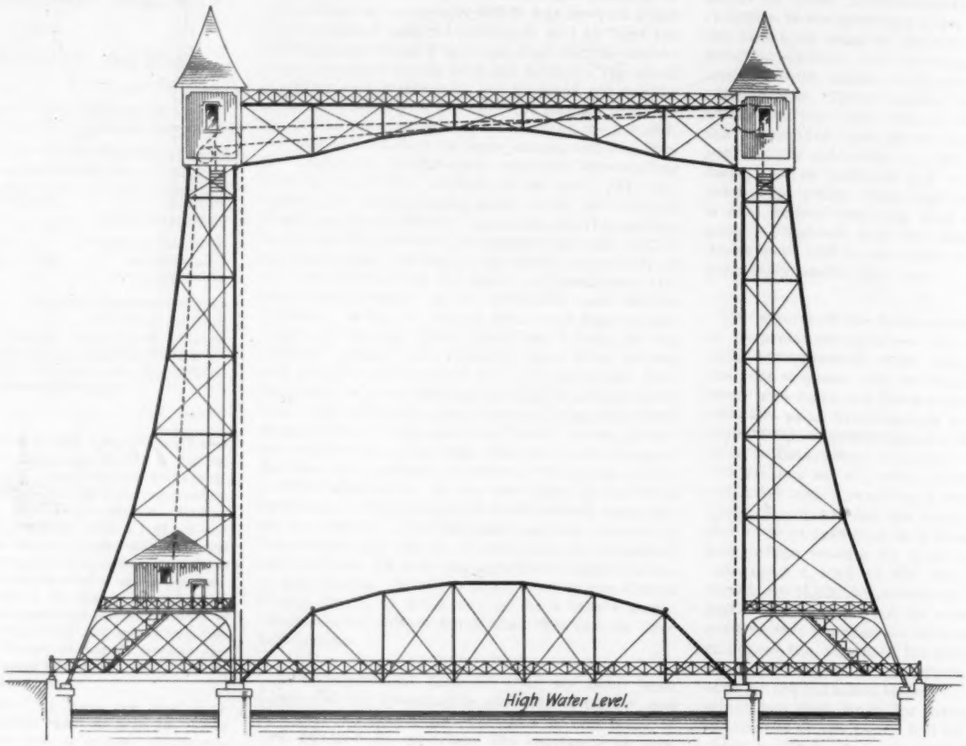


FIG. 5. DESIGN OF F. S. WILLIAMSON, M. AM. SOC. C. E. AND ALFRED LIEBMANN.

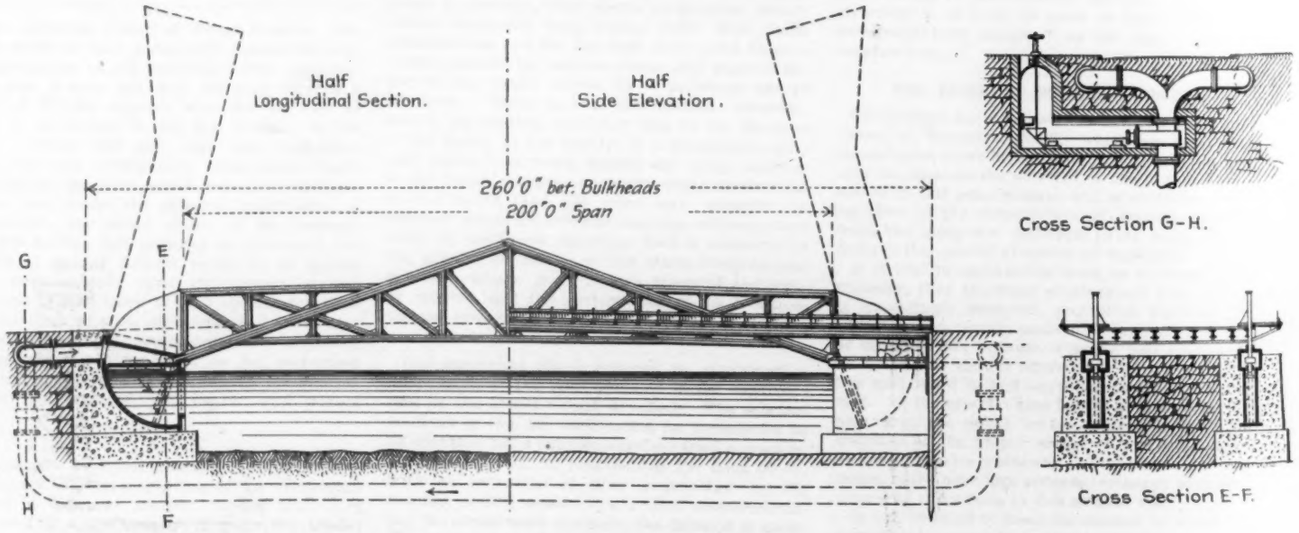


FIG. 6. DESIGN OF CHAS. STEINER.

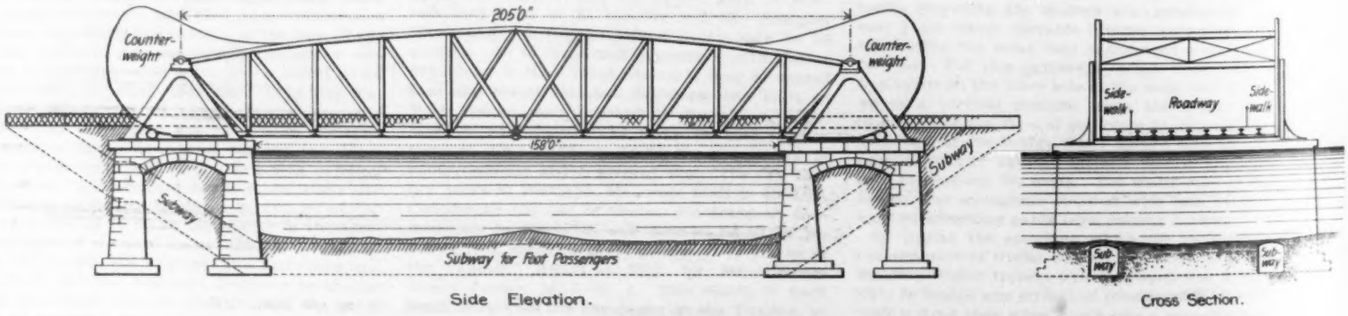


FIG. 4. DESIGN OF E. B. JENNINGS.

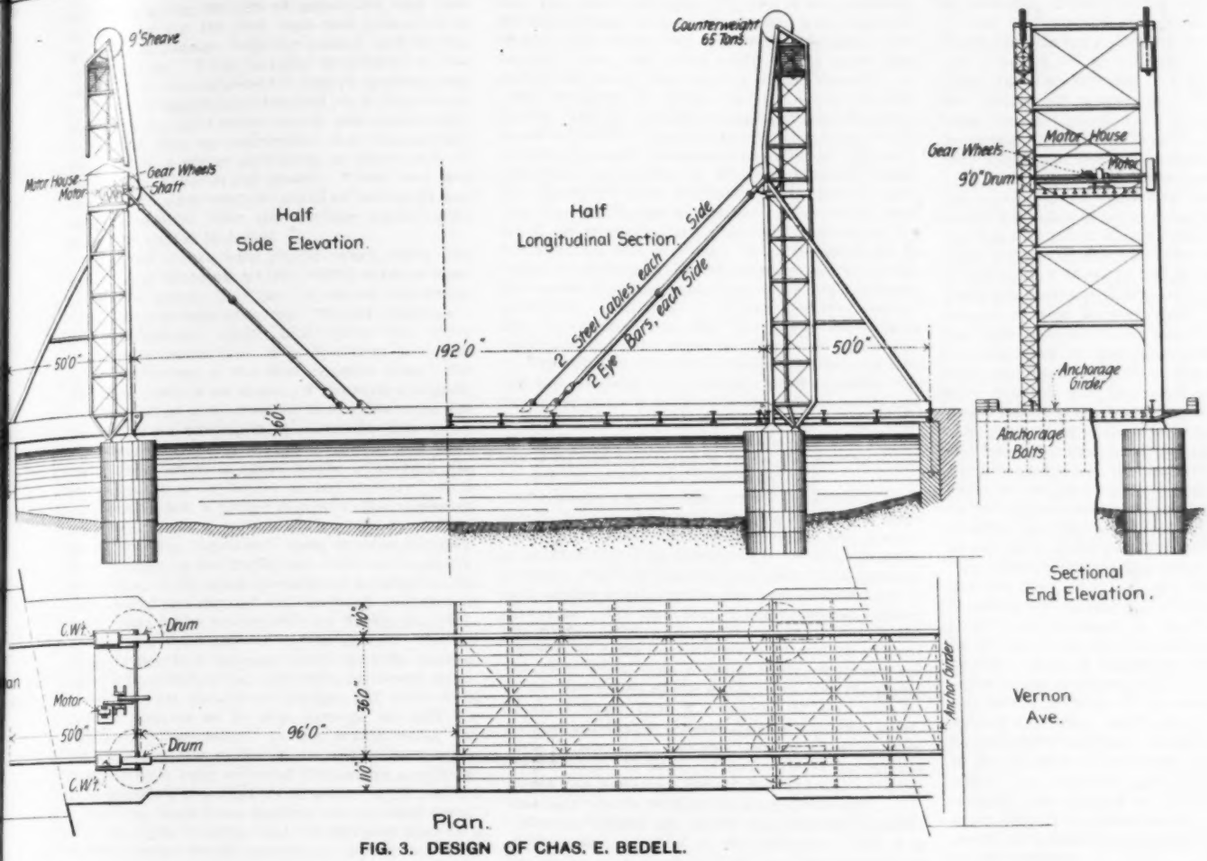


FIG. 3. DESIGN OF CHAS. E. BEDELL.

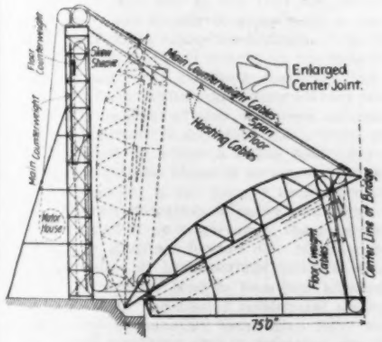


FIG. 2. DESIGN OF WM. H. BREITHAUPT, M. AM. SOC. C. E.

DESIGNS FOR

VERNON AVE. DRAWBRIDGE

OVER NEWTOWN CREEK,

BROOKLYN,

N. Y.

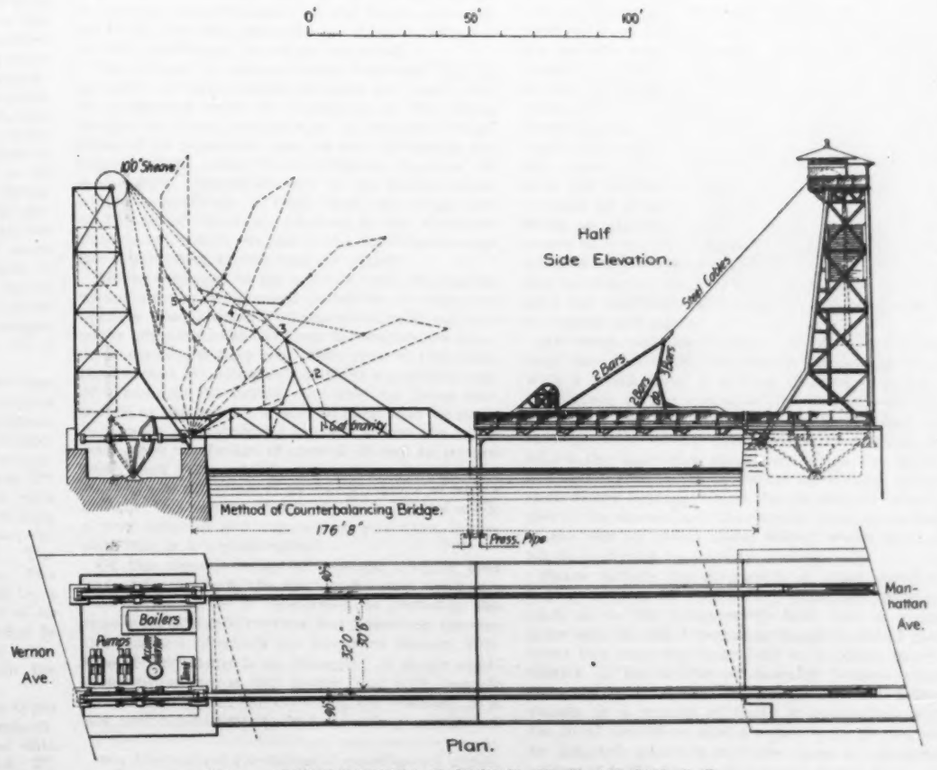
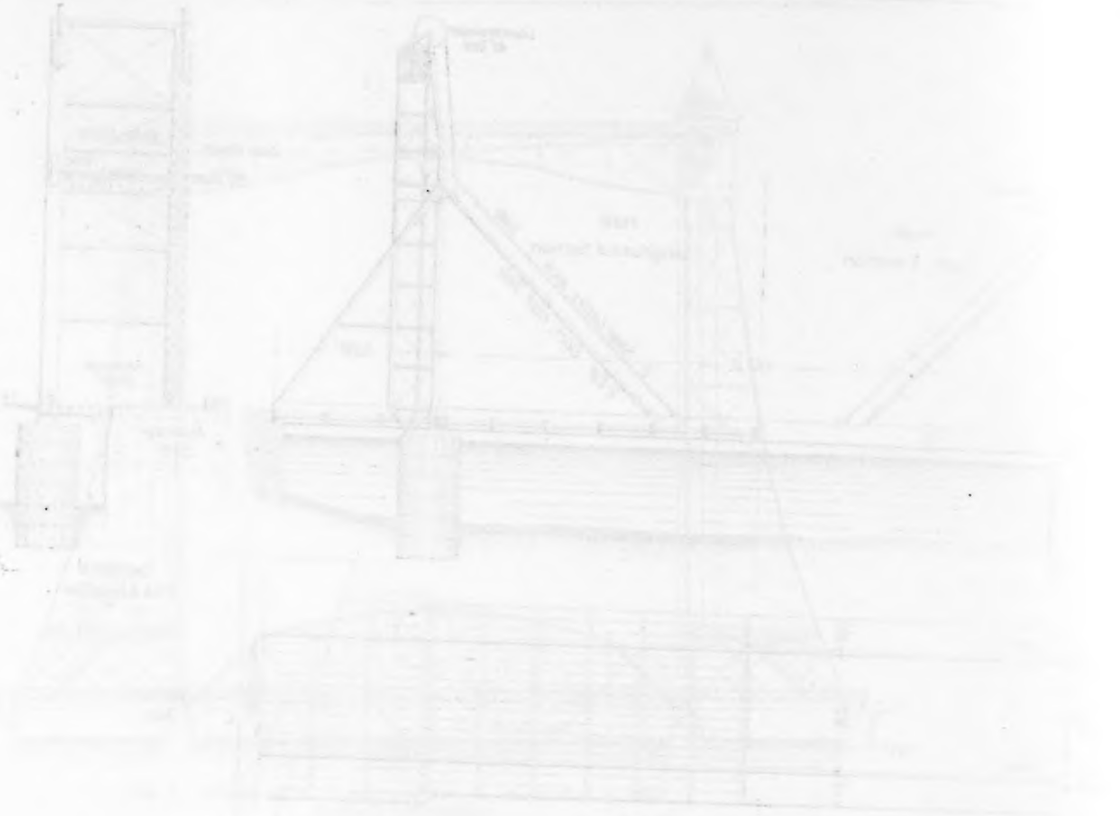


FIG. 1. DESIGN OF THOS. E. BROWN, JR., M. AM. SOC. C. E.



across navigable streams of some size, and then the problem for the first time was presented of providing a passage both for vessels and for the bridge traffic. While various structures of the bascule type were devised for narrow openings, the spans to be moved soon reached such dimensions that with the hand power which was alone available at that day, the only course open was to build the span on a center turntable, or pivot, and revolve it in a horizontal plane. When iron and steel construction took the place of timber, it was entirely natural that the wooden swing span should be copied in metal.

It is only within very recent years, since the necessity of bridging waters which carry a busy traffic has arisen, that the defects of the swing bridge have become apparent. For all crossings of any considerable width, and where the water traffic is inconsiderable, it is doubtless true that the swing bridge is the best possible type. The structure itself is as stable, if properly designed, and erected, as a fixed span; and, aside from the machinery for turning it, it costs but little more. But when we come to narrow channels, and especially those where a large traffic is moving, the swing bridge is no longer so satisfactory. In a narrow channel, a center pier with the necessary draw-rest forms a serious obstruction to navigation. The time required to open or close it constitutes a delay to the traffic both over and under it. The swing of the arms necessitates keeping a considerable of the channel unobstructed and may in some cases make unavailable for docks, etc., valuable water-front adjacent to the shores. The liability to accident through collisions with passing vessels is considerable, and such accidents sometimes not only disable the bridge, but leave it in such a position as to stop passage through the channel. The danger to the traffic using the bridge, when the bridge is open, has been made familiar by a long series of distressing accidents. It is doubtless true that no structure could prevent a runaway team from dashing into an open draw; but it is quite possible that the elevated floor of a bascule bridge would prevent an electric car from taking such a fatal plunge as occurred at Cleveland less than a year ago, and it can be made to form a barrier which is a certain protection to ordinary foot and vehicle traffic.

We may add to this that the swing span thus far is the despair of those with a regard for the aesthetic in bridge construction. Its development thus far has been strictly on the lines of maximum strength with minimum material, and the resultant form, while undeniably correct from an engineering point of view, is a most awkward and ugly monstrosity to an artistic eye. There may be some method by which a swing span may be made a graceful and pleasing structure, but so far as we are aware, it has not yet been discovered. While this consideration in many situations will be considered of no importance, the tendency is all the time growing toward the requirement of some features of architectural merit in the bridges of city streets; and in locations adjacent to public parks or the choice residential sections of large cities this matter may often have more weight than anything else in selecting the design for a structure.

Turning now to the types of movable bridges other than the swing span, they may be classified broadly as straight lift bridges, pontoon bridges, rolling bridges and folding or bascule bridges; each of these classes, the latter especially, including a great variety of designs. The straight lift bridge is simply an ordinary bridge span with cables attached at each end passing over towers and with a counterweight attached. To open the bridge the span is lifted straight upward. The pontoon bridge explains itself by its name. The rolling bridge is mounted on wheels running on a track and rolls straight back in the direction of its axis to open the channel. The bascule bridge is a bridge in which the floor lifts or revolves backward toward the end of the span to open the channel.

Some interesting examples of these various types of construction were furnished by the competitive designs for a draw bridge over the ship canal at Duluth, Minn. (Eng. News, Oct. 27, 1892.) Of the 12 designs presented in this competition, one was a straight lift, two were pontoons, six were rolling draws, and only one was a bascule bridge. The other two were swing bridges with unequal arms, and pivot piers on the shore, the ends of the long arms meeting in mid-channel.

The straight lift bridge has the merit of simplicity; but its reputation has been somewhat injured by several unfortunate accidents which have befallen the only prominent example of this construction, the Halsted St. bridge at Chicago. From the experience there it would appear that to make this type of bridge a success the greatest care must be given to the operating machinery in every detail, and it should be so designed as to make the failure of the mechanism so as to stop the working of the bridge an exceedingly remote possibility. This type of bridge is rather expensive to operate from the fact that the entire weight of the span must be lifted. It leaves the streets unprotected when it is raised unless an additional provision of automatic gates is made. On the other hand it may be made a very handsome structure, and an especial advantage in the case of the Vernon Ave. crossing is the ease and economy with which changes in its height may be made to suit changes in the street level.

The pontoon bridge has never been actually used where frequent and rapid opening and closing were essential. Some interesting designs which contemplated this were submitted in the Duluth competition, but it is doubtful whether rapid opening and closing could ever be attained by this type of structure. The fact that it has to swing against the traffic, moving in one direction, increases the amount of delay necessary and it will be evident that it is worse than a swing bridge with respect to its obstruction of the water front, and the sweep of clear water that it requires. It may also be pointed out that it is essentially a low-level structure, whereas a movable bridge over a busy stream ought to have its normal level far enough above the water to permit the passage of most mastless vessels without opening the bridge.

Rolling bridges are chiefly objectionable because of the space required by the structure when it is drawn back on shore to open the channel and for the complication in approaches which is necessary. In the case of a double rolling bridge, the ends meeting in mid-channel must be locked together to make a continuous truss, as it is hardly feasible to provide counterbalance on the shore arms for live load. Existing examples of rolling bridges are of very small span, so far as we recall.

The folding, or bascule, bridge has been built in a variety of types during the past few years, and is at present, with the exception of the swing bridge, the most popular type of movable bridge Some of its popularity may be due perhaps to the success of the noted Tower bridge in London. It is certainly remarkable that in the Duluth draw bridge competition of 1892, only one design out of 12 was of this type, whereas in the Newtown Creek competition, six out of the eight designs are for a structure of the bascule type.*

The advantages of the bascule type of movable bridge may be enumerated as follows: It leaves an entirely clear channel.; it interferes with no dock space adjacent to the towers; it requires less power to operate it than any other type of structure, the average lift being only half (or a quarter) that of a straight lift bridge, and one end being supported at the tower. The span itself may be made to furnish an automatic barrier across the roadway when the bridge is opened. It can be opened and closed very quickly, and in its motions takes no space in the channel as do all classes of swing bridges. Its towers enable the bridge to be made a very graceful and ornamental structure, wherever this is a consideration.

Of the various types of bascule bridges that have been devised, the least expensive, when the cost of operation is considered, is probably the type with a single moving leaf spanning the entire channel, of which the design of Messrs. Wilkens & Creuzbaur is an example. A single operating-house moves this bridge, and with bascule spans, meeting at the center of the channel, it is not yet demonstrated that operating machinery on each side of the channel will not be necessary. It may be objected that this type of bascule leaves the roadway open at one end when raised, but it ought not to be difficult to provide automatic gates at this end worked by the raising of the bridge. Of course, for very long spans, the truss would become very heavy to handle; but for spans of moderate length, it appears to be a very promising type of bascule.

Of the bascules with arms meeting in mid-channel, a variety of types are shown on our inset sheet. Two classes are represented, those in which the span is made continuous by connecting the lower chords of the two halves when the bridge is closed, and those in which the floors and their loads are carried entirely on suspenders from the towers or from an everloaded construction. With the first class the tower may be made very light, or may even be dispensed with altogether; but the truss itself must of course be made considerably heavier, and the connection of the lower chord might prove rather complicated.

A problem of some interest in connection with the bascules supported by inclined suspenders from the towers is the method by which the two parts of the span will be kept at the same level at the center when a heavy load crosses. It will be seen that the weight of the span itself is balanced by a cable running to the counterweight. The office of the eye-bar suspenders is to support the live load, and they will evidently hang in a considerably flatter curve when the bridge is loaded than when it is empty. It will probably be necessary to provide locking gear to keep the abutting ends at the same level.

The problem which has been solved in the greatest variety of ways is the method of counterbalancing the span uniformly in all its positions. Several different plans of affecting this are shown in the designs on the inset sheet. The system in which the counterweights hang in a chain, which transfers its weight to a fixed point, or to the other side of the head sheave as the span moves, seems to promise especially well for smooth and rapid working.

The question of the best power for operating a movable bridge should have but one answer at the present day, the electric motor, in any city where a reasonably certain supply of electric current is obtainable. The only objection to it is the possibility of failure, and this is very small at the present day. Of course all movable bridges should be fitted with hand gear for moving in case of failure of the power machinery in any event, and in a very important structure an emergency steam plant with a fire-engine boiler might also be installed. The actual amount of time that is occupied in moving a bridge even over the busiest streams, is so small that the amount of power actually used is very small. With an electric motor there is no expense for power save when the bridge is actually moving, and what is of more importance, the bridge operator has nothing to do but move a switch and can give his undivided attention to the movements of vessels and traffic.

As most movable bridges require attendance both day and night, the ability to operate them with a small force is a very important matter; the saving of the wages of one or two men per shift will pay the interest on a large sum of money. It is worth noting that lift bridges, in which the operating machinery is on the shore, are better adapted to operation by electric power than swing bridges where the machinery is on a pier in the stream and the current must be carried to the pier by cables under water, which are liable to be fouled by passing vessels.

Space forbids the discussion of other interesting questions in connection with the subject, such as to the comparative first cost of swing span and bascule structures; but it is hoped that what has been said may lead to a better appreciation of the merits of movable bridges other than the swing span. The design of every bridge should be a matter of study in connection with the local conditions and a swing span should not be adopted where a movable span is necessary unless it fulfils the requirements better than any other type.

*For drawings and descriptions of recent bascule bridges, see Engineering News, May 23, 1891; Dec. 14, 1893; Jan. 18, 1894; Feb. 21, 1895, and March 7, 1895.

LETTERS TO THE EDITOR.

Early French Movable Dams.

Sir: Can you refer me to any descriptions of the primitive movable dams used in France, say prior to 50 years ago, and of the Thenard shutter?

Very truly, "Barrage."

State College, Pa., Oct. 28, 1896.

(In the "Proceedings of the Institution of Civil Engineers," Vol. LX., p. 24, will be found a paper on "Fixed and Movable Weirs," written by Mr. L. F. Vernon-Harcourt, M. Inst. C. E. This paper describes the Poiree needle-weir, of 1834, the movable shutter of M. Chanoine, and the drum-weir, bear-trap weir, segmental gate weir, rolling shutter and the various hydraulic shutter weirs, all used in the improvement of the River Seine. The needle-weir, which seems to have been one of the earliest forms, was made up of a series of needles, or bars, 11½ ft. long, and 3 ins. square, furnished with hooks by which they revolved on the top-bar of a supporting trestle of iron work. They were used side by side with shutter weirs and were regarded as simpler in construction, more easily moved and less liable to get out of order than the early types of shutter weirs. The Chanoine shutter or wicket was introduced upon the Seine about 1860. Our correspondent is also referred to the published work of Mr. Vernon-Harcourt on "Rivers and Canals." We regret to say that we can give no detail of the Thenard shutter.—Ed.)

A Puzzle in Mechanics.

Sir: A problem in mechanics recently given to the students here has attracted considerable attention and aroused no little enthusiasm. I take the liberty of stating the problem and asking that you give your solution:

"A man stands on a perfectly level, solid and frictionless table, large enough so that he will not fall off. Nothing but air surrounds him and he has nothing to throw. How can he get off the table?"

Of a number of answers given, the most sensible were, that he could swim off or blow himself off. But when action and reaction are considered, even these seem impossible solutions. Of course a quick exhale would produce some motion, but the inhale would also tend to move him back to his original position, and so with his hands if used as in swimming. When he threw them out he would move nearer his destination, but when he drew his hands back again would he not tend to move toward his original position? Again, is it possible for him to turn his head, even slowly, without a movement of his feet?

You will note that the problem brings up a number of complicated questions, and I hope you will give me your idea. Very respectfully yours,

Chas. W. Gennet, Jr.

Chi Psi Lodge, Ithaca, N. Y., Oct. 29, 1896.

(The man could blow himself off for he could inhale vertically, through the nostrils, which would produce no horizontal reaction, while he could exhale horizontally through the mouth. He could also inhale slowly and exhale rapidly. He could also get off by a swimming motion, for he could move his hands in one direction while they were placed so as to cut the air, and turn them to act as paddles against the air before moving them in the opposite direction. We think he would not be able to turn his head without moving the rest of his body, for the motion is produced by contraction of some muscles in the neck, which would act at both ends, pulling the head in one direction and the body in the other.—Ed.)

Wright's "Element of Mechanics."

Sir: In the review of my "Mechanics," contained in Engineering News of Oct. 22, the reviewer advances views which to say the least are misleading.

1. The reviewer takes to task writers who do not follow the methods of twenty years ago, but introduce innovations.

The answer is not far to seek. The Mechanics of to-day, unlike that of twenty years ago, is not for the civil engineer only. The electrical engineer and physicist have come to the front in the meantime. They must have a notation and units as well as the civil engineer. His are not sufficient for the reasons stated in the book (p. 62). Hence to the gravitation system of units is added the absolute system, and hence the new terms micron, megadyne, kilo-watt, barad, etc. Hence, too, the theory of dimensions at which the reviewer sneers. Without an account of the theory of dimensions any book on Mechanics is antiquated.

The introduction of new terms is, therefore, to be looked for mainly* in a region in which the civil engineer has hardly any concern. And by omitting to read the last chapter he may never meet them. At least the reviewer has found nearly all that excites his ire in the domain of the physicist and electrician.

The terminology given is that of the best authorities, the British Association Committee and the International Electrical Congress held at Chicago in 1893. I have been careful not to add anything as I am as much opposed to terms not authorized as is my critic.

2. Twice my attention is called to the absence of the relation

$$M = \frac{W}{g}$$

or mass is equal to the quotient of the weight by the factor g.

This is found in all the old books and has, I venture to say, been a source of endless confusion. Its elimination marks a great advance.

The factor g is introduced to change from an absolute to a gravitation system, or vice versa (p. 60). When this is understood the question "whether shall I multiply or divide by g" is answered.

3. In order not to make this letter too long I will not enter upon a discussion of the questions raised regarding force and energy. The definition of force laid down is that given by Newton in his first law of motion and is not a verbal hair-splitting by any means.

It would seem that, after all, progress in Mechanics is possible—in fact modern physics is rapidly assuming the form of a dynamical problem. T. W. Wright.

Schenectady, Oct. 27.

The Economy of Steam Shovel Work.

Sir: In your issue of Sept. 24, you give in detail the bids on the "Nashua Aqueduct," for the new Metropolitan water supply. These bids make an interesting showing of the advantage which any contractor has who uses steam shovels for work of any magnitude. The successful bidder on this work has been using a Vulcan "Little Giant" steam shovel and based his bid on what he knew could be done at a profit. The work comprises 290,000 cu. yds. of earthwork and stonework of different kinds. There were 21 bids opened, and the totals ranged all the way from $86,960 to $401,275, quite a difference. The lowest bid was rejected. The next lowest and successful bid was $89 470. In this bid the 290,000 cu. yds. of earthwork were priced at 18 cts. per cu. yd.

I give below a statement in detail, showing how much lower than the successful bid each one would have been if each had figured the earthwork at the same price (18 cts. per cu. yd.) Strange as it may seem, the highest bid, $401,275, if figured at 18 cts. (the lowest price), would have been $12,995 lower than the successful bidder. It was actually $324,800 higher on the excavation.

Yours truly,

The Vulcan Iron Works Co.,
Alex. Backus, President.

Toledo, O., Oct. 26, 1896.

Table Showing the Effect of High Estimates for Earthwork in Bids for Nashua Aqueduct.

Bid No.	Price per yd. over successful bid, cts.	Excess on the earthwork.	Actual total bid.	Had each bid been 18 cts. per cu. yd. on earthwork, the bids would have been: For whole work.	Or less than successful bid by.
1	3	$8,700	$86,960	$78,260	$11,210
2	...	.....	89,470	89,470	.....
3	4¾	14,137	90,117	75,980	13,490
4	4	11,600	94,372	87,772	6,698
5	6	17,400	97,150	79,750	9,711
6	7.6	22,040	97,500	75,460	14,001
7	5.5	15,950	103,495	87,545	1,925
8	11	31,900	114,920	83,020	6,450
9	14.9	43,210	119,115	75,905	13,565
10	14	40,600	120,230	79,630	9,840
11	12	34,800	120,362	85,562	3,908
12	12	34,800	121,882	87,082	2,388
13	17	49,300	125,932	76,632	12,838
14	15	43,500	130,076	86,576	2,894
15	17	49,300	134,745	85,445	4,025
16	21	60,900	146,660	85,760	3,710
17	21.5	62,350	149,850	87,500	1,970
18	28	81,200	172,646	91,446	1,976
19	31	89,900	175,172	85,272	4,198
20	48	139,200	228,837	89,637	167
21	$1.12	324,300	401,275	76,475	12,995

Salinas Bay as a Pacific Terminus for the Nicaragua Canal.

Sir: I notice in your paper of the 8th inst., a letter from Mr. Sylvanus Miller, M. Am. Soc. C. E., in which, among other things, he advocates a survey of the Salinas Bay route for the Nicaragua Canal, on the west side of the isthmus. It is undeniably the fact that the surveys made by the Nicaragua Canal Construction Co. were too much confined to one route, but I must take exception to Mr. Miller's assertion that the surveys on the Salinas Bay route were not thorough and complete enough. It must be remembered that we went out there for the purpose of locating one of two predetermined routes, and not, like a government expedition, for the purpose of exploring the isthmus. That had been done previously by the U. S. Government, by the Government of Nicaragua and by various private companies and persons; and as a matter of information I will inform Mr. Miller that a survey of the Salinas Bay route had been made by Col. [illegible], in 1851, and by the parties under command of Commander Lull, in 1874.

However, the first thing that I did after being placed in charge of the Nicaragua Canal, was, in obedience to orders from the chief engineer in New York, to send one of my assistants, with a full field party, to Salinas Bay, to make a careful survey of this route and settle the question; which, by the way, had been twice settled before. I always supposed that this survey was ordered to appease the Costa Rica Government, in whose territory it lay, and who naturally wanted the canal terminus in their republic, if possible.

Be that as it may, my assistant, Col. Perez, went to Salinas Bay and started the survey toward the lake, and a copy of his report is before me. Before they had proceeded three miles they attained an elevation of over 800 ft., and were confronted with perpendicular rock cliffs, which they could not scale without making a great effort. They examined the country thoroughly, all about the bay, and this was the best line they could find. It was intended to take the line down the valley of the Sapoa River, an insignificant stream, emptying into the Lake Nicaragua, or any other that could be found that would better answer the purpose; but upon receiving his preliminary report, it was seen to be utterly impracticable, as much as we would have liked to utilize the fine harbor of Salinas, and I therefore recalled the party.

While the Salinas Bay line is unfortunately impracticable, I will say that I know that a better line, more economical and more practicable by far than the line selected by the Nicaragua Canal Co. does exist. It is thoroughly known to me, and I have personally examined it; a line that will do away with the immense divide cut and most of the other objectionable features of the line we were sent out to locate, and which had previously been selected by the company. If I had been sent out there by the company to find and locate a line across the isthmus that would be the best and most practicable and least expensive, I should certainly have selected the line referred to; we were not, however, sent out for any such purpose, but to make the best and most thorough location on the route previously determined upon, which comprised the high and low level lines that we surveyed, and I found by experience that any suggestions in regard to other routes were not received with favor.

In regard to the line that we did locate, I venture to say from an experience of over 25 years on public works that no public work ever projected, and I make no exceptions, ever had more complete, thorough and careful surveys, examinations and studies than the upper route of the Nicaragua Canal; and if the U. S. Commission had seen and examined all of the surveys, preliminary and trial locations, reconnaissance and fly-lines, cross-sections, check and counter-check levels, measurements and gaging of streams, determinations of river slopes and oscillations, soundings and borings, rainfall records, barometric levels, lake oscillations, etc., etc., they would have been forced to the same conclusion. But from reading their report, it would appear that the half of the data collected and forwarded to the home office by myself and my predecessor, Lieut. Peary, had never been collated and placed before them. J. Francis Le Baron.

Late Principal Assistant and Division Engineer in charge, Nicaragua Canal.

Jacksonville, Fla., Oct. 9, 1896.

*Mainly, but not wholly, as for example, torque and horse-power-hour.

TESTS OF THE ROEBLING FIREPROOF FLOOR.

In our issue of Sept. 17, we described a test which was made in New York city, on Sept. 3, of a fireproof floor constructed by John A. Roebling's Sons Co. A description and illustration of the system of construction, and of earlier tests upon it, was given in our issue of July 18, 1895. In that test the floor was subjected to a hot fire for two hours, and was then cooled by water, and found to be uninjured. As a protest sent to the Building Department of New York city claimed that two hours was not a sufficient time for a thorough test, it was decided to have a second test for a period of five hours. This test took place on Oct. 28, and its conclusion was witnessed by a member of the staff of this journal. Invitations had been freely sent out by the builders, and a large crowd was present, including many engineers and others interested in fireproof building construction. The test was made in the same building that was used in the former test, its location being an open lot at 81st St. and Western Boulevard. It is a steel skeleton brick structure, built after designs of Mr. G. C. Henning, the expert of the Department of Buildings, who also was in charge of the test. The size of the test

structure is 12×16 ft. in area, by 12 ft. high. The floor was made of 10-in. I-beams, 25 lbs. per ft., 15 ft. 6 ins. between supports, spaced 4 ft. apart between centers, with concrete arches 3 ins. thick at the crown sprung across the beams. The concrete was made of 1 part Aalborg Portland cement, 2 parts sand and 5 parts ashes, from steam boiler furnaces. A filling 2 ins. thick was placed between the nailing sleepers, consisting of a concrete made of 1 part Aalborg cement, 2 parts sand and 10 parts ashes. A ceiling was placed under two-thirds of the floor, made of wire netting and lime plaster furnished by the United States Mortar Supply Co. The remainder of the floor was left unprotected. The floor arches were concreted on Sept. 26, and the ceiling plastered on Sept. 30 and Oct. 1. A grating extending over the entire floor area was fixed at about 3 ft. above the ground, and on it was placed a 2½-ft. layer of dry hard cord wood, sprinkled with oil, so as to cause it to ignite readily. A second grate about 2 ft. below the first was also supplied with fuel with the object of heating the air entering the building and thereby creating a higher final temperature. Before the test the central panel of the floor was loaded with brick to 150 lbs. per sq. ft. The test was begun by lighting the cord-wood, at 10.06 a. m. The temperature was measured and graphically recorded by a Uehling & Steinbart pyrometer, which worked perfectly throughout the test. Some of the temperatures recorded are the following:

Time.	Temperature.	Time.	Temperature.
10.40 a. m.	1,100°	1.03 p. m.	2,050°
11.00 "	1,450°	1.33 "	2,050°
11.20 "	1,725°	1.55 "	2,125°
12.00 "	2,000°	2.11 "	2,050°
12.23 p. m.	2,100°	2.28 "	2,100°
12.43 "	2,300°	2.51 "	2,000°

From 11.55 a. m. to 2.51 p. m. the temperature was never less than 2,000°. This is a more uniform range of temperature than has been obtained in any of the previous tests by the Department, or in any other fireproofing tests ever made, so far as we are aware: At 3.06 p. m., a strong stream of water from a fire engine was thrown directly against the underside of the floor. When the structure had been sufficiently cooled, and the steam cleared, so that the floor could be inspected, it was found that the ceiling of wire netting and plaster had disappeared, but the arches were to all appearances uninjured, and the floor sustained its load. The maximum deflection of the roof before the water was put on was about 4 ins. On the next day the load on the roof was increased to 600 lbs. per sq. ft., which load was sustained without any signs of failure.

A comparative test of the Roebling system and ordinary hollow tile flooring was made on the day preceding the official test above described, in an adjoining structure. We abstract the following from a printed statement issued by the John A. Roebling's Sons Co.:

On Sept. 3 a comparative fire and water test was made in the smaller of the two brick structures at 82d St. and Western Boulevard, New York city. Two fireproof floor arches had been built in the structure, about 8 ft. above the ground, one according to the Roebling system; the other, an ordinary sectional hollow brick flat arch. A concentrated load of common brick, weighing 9,000 lbs., was distributed over about 15 sq. ft. near the middle of the arch. A hot fire was started and maintained underneath these arches for about an hour and a quarter, after which the water was turned on by a detachment of the Fire Department. After the fire was extinguished, it was found that both arches had sustained the test without apparently any damage other than the displacement of some of the plaster and a slight deflection of the hollow brick arch.

It was claimed by some of the persons present that the test was without significance, and that to have any value, the arches should be fired until one or the other failed. Acting on these suggestions, the ceilings of both arches were replastered on Oct. 1. A second fire and water test of these same arches was made on Oct. 27. Pig iron weighing 10,000 lbs. was piled over an area of about 7 sq. ft. in the center of each of the two arches, making a superimposed load of over 1,400 lbs. per sq. ft.

At 10.00 a. m. the fire was started.
10.30, the white coat of plaster off in many places, and at others, clinging to ceiling.
10.50, plaster still intact under both arches.
11.45, rough plaster of ceiling still intact under both arches. Copper plug for indicating temperature not fused.
1.00, rough plaster still in place; copper plug not fused.
1.35, copper plug fusing.
1.50, cracks beginning to form around load in hollow tile arch.
1.55, cracks opening parallel to wall and adjacent to it along both arches. That portion of the hollow-brick arch directly under load slightly depressed below level of the remainder of arch. Joints opening and smoke issuing around load on flat arch.
2.05, load over flat arch dropped through suddenly to the ground inside the brick structure.

Iron work erected Aug. 10; Roebling arch concreted Aug. 11; flat arch erected Aug. 10 to 11; first fire and water test Sept. 3; ceilings replastered Oct. 1; thickness of crown, Roebling arch, 3 ins.; depth of hollow brick arch, 10 ins.; size of beams, 10 ins.; 25 lbs.; spacing of beams, 5 ft., center to center; proportions of cement mortar used in setting flat arch, 1 part Aalborg Portland cement, 1 part sand; proportions of concrete used in Roebling arch, 1 part Aalborg Portland cement, 2 parts sand, 5 parts steam ashes.

This test was an unofficial test, but was witnessed by several members of the Department of Buildings as well as a number of others interested in the subject of fireproofing.

THE VILLA BRICK MANTLE, FOR PROTECTING RIVER BANKS FROM EROSION.

Signor Giovanni Villa, of Milan, Italy, has invented and now tested for some years a system of protection for the banks of rivers and canals that is simple and cheap and certainly possesses meritorious features. This protective device is a mantle made of perforated bricks of terra-cotta or cement strung upon galvanized iron wire and connected laterally, between each row of bricks, by a strip of wood. The bricks vary in dimensions so as to break joints, as shown in Fig. 1. Mr. Villa

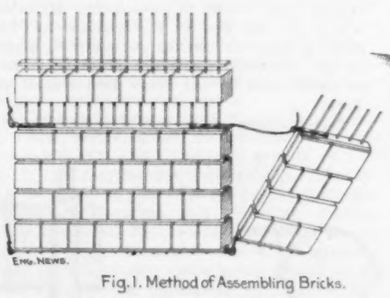


Fig. 1. Method of Assembling Bricks.

Fig. 1.—Details of Construction of the Villa Brick Mantle for Protecting River Banks From Erosion.

has designed a special apparatus for making the mantle and for putting it in place on the river bed.

The mantle is applied to an eroding river bank in sections varying in width from 5 to 10 ft. with the character of the work; but these strips are also united together by wire at intervals, as shown in Fig. 1, and are anchored to the shore above the water-line. The resulting mantle, or covering, is strong and flexible, adapting itself to the conformations of the river bottom and extending from any desired point in the river to the bank. It is quite smooth and permits the water to flow easily over it. The inventor makes the following claims for this mantle: Cheapness, as compared with other methods of accomplishing the same end; great efficiency and duration; and rapidity and ease in making and laying. There is no obstruction to the normal flow of water in the river, and the deposit of fine mud carried into and behind the mantle only tends to give it greater permanence.

As to the important claim of durability, it seems that the first mantle was tried about five years ago on the River Olona, near Milan. Here a dike protecting some agricultural lands from inundation was faced for a distance of about 3,000 ft. on the Villa system. In 1895 this work was in good condition and grass was growing between the bricks. On the River Po, near Crespino, the mantle has been used to protect a communal hospital which was in danger from the cutting away of the bank in a curve in the river. This mantle is about 800 ft. long, and it is said to extend under the water for about 130 ft. It has stood two years' wear without any injury and has stopped all erosion, though the bank is very steep. Its cost was about $1,500, including the preparation of the bank for the mantle.

Mr. Villa says that a single threading machine will keep 15 men busy and make 180 sq. yds. of mantle "per day," without specially trained men. As to cost, the inventor supplies the following estimate for one square meter, stating that one of the chief advantages of this system of bank protection is that the cost can be definitely fixed beforehand, at so much per square yard, regardless of the stage of water, etc.:

Cost per Square Metre in Francs.

17 cement bricks	3.40	francs.
2 bundles of wooden slats	.20	"
2.2 lbs. of galvanized iron wire	.55	"
Foreman	.50	"
Tools and labor	.15	"
Cost per square metre equals	4.00	"

This is equivalent to about 77 cts. per sq. yd., though the materials and labor are doubtless figured on a European basis in the above. Mr. Villa says that the use of terra-cotta bricks would reduce the above total to 3.75 francs per meter, or say to 63 cts. per sq. yd. The plant required for a considerable piece of work is estimated as costing $20,000 in Europe, and included in this plant are:

6 barges, at 5,000 francs each	30,000	francs.
6 hand machines for threading	18,000	"
Tools	5,000	"
Chains and rope	5,000	"
12 small boats	6,000	"
Office expenses, etc.	20,000	"
Contingencies	16,000	"
Total	100,000	"

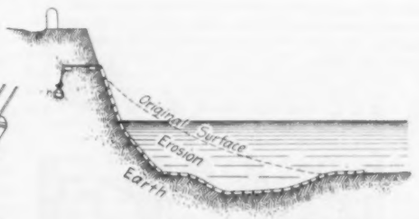


Fig. 2. Section of Shore, Showing Mantel in Position.

Fig. 2.—Cross Section Showing the Mantle in Place.

The English patents seem to be controlled by the "Villa's Patent Mantle Syndicate, Ltd.," of Liverpool; the inventor is Signor Giovanni Villa, of Milan, Italy, and the present owner of his patents is Signor Riccardo Biragchi, of Milan.

THE USE OF OLD RAILS AS UNDERGROUND CONDUCTORS.*

By F. O. Rusling.

While the writer was the Superintendent of the Buffalo (N. Y.) Railway Co., serious indications of electrolysis of the pipes within a half-mile of the power-house made it necessary to call in expert advice to put a stop to the trouble. A careful and thorough electrical survey was made of the entire district. This was a long and difficult matter, since there were three systems of natural gas pipes, two of illuminating gas, one of water and two conduit systems. Although the pipes were already connected to the negative bus-bar by large copper cables, it was found that these were entirely inadequate, and that there were two points where the pipes at heavy load were 3 to 5 volts positive to the adjacent rails. One of these points was 1,500 ft. north and the other 1,800 ft. east of the power-house.

The expert calculated that, until extensive changes could be made in rail returns, the former point would deliver about 1,000 amperes and the latter about 3,000. To bring this current to the dynamos with but 5 volts loss would need over $8,000 worth of copper. While hesitating over this large expenditure it occurred to us that there were about 300 tons of old tram rails on hand that might be used for the purpose. These were flat, center-bearing rails, originally weighing 56 lbs. to the yard, but worn down to 50 lbs. or less; they were high in carbon, hard and brittle.

*Reprinted from the "American Gas Light Journal."

The best scrap price obtainable was $8 per ton, delivered. Our expert carefully tested their conductivity with 1,000 to 1,500 amperes, using an instrument reading to .001 of a volt in order to secure accuracy. As the showing was satisfactory, it was determined to try the rails on the 1,500-ft. length, which would require four rails in parallel to give the desired results. A trench was dug between the curb and sidewalk and a continuous trough of rough lumber put into it.

The rails were bolted together in pairs back to back, and arranged so that the end of one rail was at the center of its mate. The bonding was effected by scraping contact spots with a file near the end of each rail and amalgamating them with the Edison solid alloy. A steel washer ¼-in. thick, 1⅛-in. inside diameter, and 4 ins. outside was dipped into hot insulating compound and placed against one rail so as to inclose the contact spot. The hole in the washer was filled with the Edison-Brown plastic alloy, inclosing an amalgamated steel spiral spring. The upper rail was then bolted on and the completed conductor lowered to the bottom of the trough, resting on one edge so that gravity would maintain the contacts. It will be evident that with this arrangement two of the bonds on any one rail would have to give way before the circuit could be broken; each bond was made large enough to transmit 1,500 amperes. When the second set of rails was lowered into place, the trough was filled with a hot insulating compound and a cover nailed on. This compound was cheaper and better than asphaltum; it remains viscous even in cold weather and has high insulating qualities. It is a product of petroleum distillation much lighter than asphaltum and costs about $25 a ton.

This four-rail conduit was connected up and carried at heavy load, 1,100 amperes, 1,500 ft. with a loss of but four volts. This result was so surprising that our expert suspected that his instruments were wrong and sent them back to Weston for recalibration; they were returned, but proved that the measurements were correct. To appreciate the performance of these old rails and their bonds I need only say that, to give the same result, it would require a copper section of 3.55 sq. ins.; 1,500 ft. of this would weigh 20,532 lbs., and cost at 12 cts. per lb., $2,462.83. Our four-rail lengths weighed 50 tons and cost as scrap but $400. The resistance of steel as compared with copper is usually considered to be between 7 to 1 and 9 to 1, but this including 50 bonds in each length, was about 5.63 to 1. The tests proved that the plastic bonds rails between clamps, so as to save wasting insulating compound, with wider spaces to accommodate the clamps. Rail joints were broken as before.

This construction allowed very rapid and satisfactory work compared with the first. The performance was also satisfactory, as the 14 rails transmitted 3,250 amperes 1,800 ft. with but four volts drop; an insulated pilot wire was put down with this conduit and permanently connected with a voltmeter in the power house. The rails used in this conduit weigh about 210 tons, which at $8 would amount to $1,680.

It would require a section of 12.48 sq. ins. of copper to equal in conductivity the section of 70 sq. ins. of steel. This copper would weigh 86,580 lbs., and at 12 cts. per lb. would cost $10,389. The total cost of the rails and bonds, for both conduits was about $3,322, as against $12,852 for equivalent copper. The labor to install the copper would of couse be less, but on the other hand we had the rails in stock and the only actual outlay was for labor, bonds, lumber, bolts and insulating material. I have not the details of these now at hand; my recollection is that the total expenditure did not exceed $2,500, and that we thus secured results which would otherwise have cost nearly $15,000.

From my experience with copper bonds I should not advise the use of buried rails for conduits if ordinary copper bonds are used for connections. Even when new it is impossible to get the full conductivity of the rail, and the contacts get worse and worse as time passes. The copper when covered with the damp earth will oxidize at a rate determined by the composition of the soil and the amount of current transmitted.

A 54-IN. WOODEN BARREL SEWER.

By J. C. Meem, Assoc. M. Am. Soc. C. E.

The accompanying sketches show sections and details of a typical 54-in. wooden barrel sewer, adopted from plans of similar ones, recently designed and built in Brooklyn. Mr. Chas. H. Myers, M. Am. Soc. C. E., Engineer in Charge of Sewers, however, makes no claim to originality, as the Brooklyn plans are practically the same as those used by the Dock Department of New York.

The sketches show two designs, Fig. 1, with boxed supports for pier extension, discharging through a mouthpiece in the bottom; and Fig. 2, with supports better adapted for cribwork, and with an open end discharge. The general construction is similar in both cases, except when shown to be different in the plans.

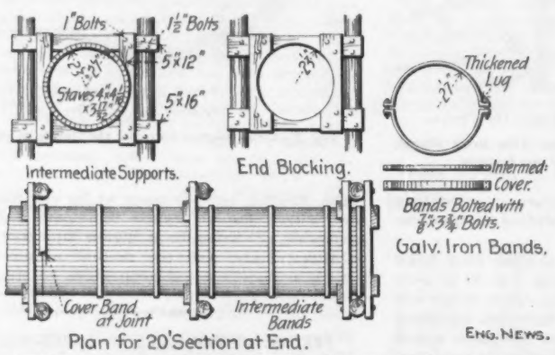


FIG. 1.—DETAILS OF BOXED SECTION WITH MOUTHPIECE AT DISCHARGE END.

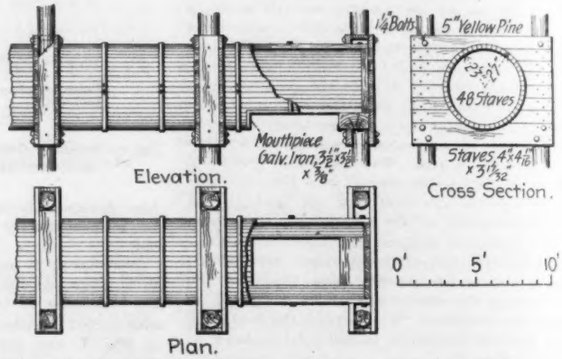


FIG. 2.—DETAILS OF PIER EXTENSION OR CRIBWORK

A 54-IN. WOODEN OUTLET SEWER AT BROOKLYN, N. Y.

The "streaks" or staves are creosoted with 10 lbs. of dead oil of tar, weighing 8½ lbs. per ft. at 120° F.

The intermediate bands and the cover bands for the joints are of galvanized iron, as is also the mouthpiece which is fitted to the opening in the sewer. This last is bolted to the staves at the four corners and to a galvanized iron strap which goes over the sewer at the center of the opening.

In constructing the sewer it is made in 20-ft. sections and floated to place at high water, or else it is set up in position, according to circumstances. A little calking may be given to the joints between sections when it is impracticable to get a good fit. The simplicity of their construction and the durability of these sewers make them especially desirable for this character of work.

The sewers are built in elliptical or other shapes as well as circular, according to necessity.

THE FAIRMOUNT PARK ELECTRIC RAILWAY, at Philadelphia, Pa., is now completed and nearly ready for traffic. It opens up communication with all parts of the great park, and all roadways and drives are crossed below grade. The power-house has an engine room 55 × 55 ft., and a boiler room 156 × 36 ft., with a large coal storage vault. There are three tandem compound Corliss engines, each directly connected to a General Electric dynamo of 500-K-W. capacity. Steam is supplied by six Berry vertical boilers of 250 HP. The boilers and engines were built by Robert Wetherill & Co., Chester, Pa. The car shed is 425 × 114 ft., of ornamental design. The equipment includes 30 motor cars and 30 trail cars, each seating 72 passengers. Each car is mounted on two four-wheel trucks, with 33-in. wheels, and each motor car has four motors. All the cars have electric brakes. They were built by the J. G. Brill Co., of Philadelphia, Pa.

NEW STEEL MAKING PROCESSES claimed to supersede the Bessemer process, are invented every year or two, and achieve a brief notoriety through the medium of the daily papers. The latest is the Hawkins' process, which is described in three columns of fine print in the St. Louis "Globe-Democrat" of Oct. 25. As nearly as we can understand, the operation of the process is as follows: Pig iron melted in a cupola flows in a stream into a reverberatory furnace beneath; the stream is met by two jets, one of air and one of steam. The steam or hydrogen blast is supposed to turn sulphur into a gas that is burned up, and to turn the phosphorus into a slag which floats on top of the melted metal. The latter is then tapped out of the reverberatory furnace or "converter." Experiments are said to have been made with the process by Chicago capitalists at the old Jefferson Steel Works in Birmingham, Ala., in a plant which was erected at a cost of $10,000. A dispatch received from them says "Parties interested jubilant over results and declare it a revolution in steel making." The most absurd claims are made for the process, such as that steel may be made by it as cheap as cast iron, and that steel castings made from the Hawkins' process are equal to steel forgings.

ALUMINUM CAN BE SOLDERED OR BROWNED, says Dr. Gottig, in the "Metallarbeiter," as follows: The aluminum is treated with a solution of ammonia alone, or with ammonia in the presence of salts of ammonia. In the first case, the aluminum, which always contains a little iron and silica, is dissolved on the surface; but the silica and the iron remain and form an adhering coating of a brownish yellow or a blue-grey color; the color varying with the amount of impurities in the metal. In the case of the treatment with ammonia in the presence of salts of ammonia the iron is also dissolved and the silica alone remains. But the combination formed reacts upon the ammoniacal salts and the deposit of hydrate of alumina and oxide of iron again forms a protecting coating. The physical and chemical properties of the surface of the aluminum are so modified that this surface will resist the action of humid air and waters slightly acid. Another advantage is that the aluminum thus treated can be easily soldered and electrolytic deposits will adhere strongly.

THE WESTERN UNION TELEGRAPH CO., according to its annual report for the year ending June 30, 1896, owns 826,929 miles of wire, has 21,725 offices, forwarded 58,760,444 messages, for which it received an average toll of 30.9 cts. at an average cost per message of 24 cts. In 1893 it transmitted nearly 66,600,000 messages and received 31.2 cts. for each at a cost of 22.7 cts. The gross earnings for the year 1896 were $22,612,736, with operating expenses of $16,714,756 and net earnings of $5,897,980. The company is reconstructing its trunk lines with copper wire, with excellent results.

actually did make an "electrically continuous rail," and after a year's service they are still maintaining their conductivity. This is more than can be said of any copper bond ever used. It will be noted that steel like this, even at $30 per ton, would be cheaper than copper as a conductor.

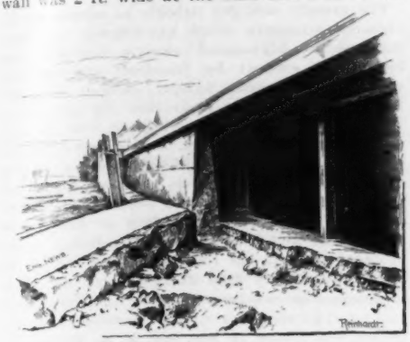
As the steel was so hard and brittle, a great deal of time was required to file the contact spots and to bore holes for the bolts to hold them together, so another method was adopted in the second case. In the power-house is an air compressor for cleaning out armatures and removing dust from the boiler-house walls. An iron pipe was connected from the air reservoir to the yard and a single layer of rails, bottom up, was put on each wagon. Each load was carried into the yard and the contact spots were rapidly cleaned with a reciprocating pneumatic tool, borrowed from a boiler shop. To avoid drilling the rails, pieces of ¾-in. iron, about 24 ins. × 8 ins., were placed in the trough every 15 ft. These were bored at the ends for a pair of countersunk ¾-in. bolts and had four contact spots cleaned with an emery wheel. On these were laid the plastic bonds and four rails side by side, with base down. The spaces between the treads were just right for a second layer of three rails bottom side up. Then another set of bonds and an iron plate ¼-in. thick, 20 × 8 ins. On these more bonds, other layers of four and three rails, and finally a ⅜ × 24 × 8-in. top, bolting all layers together. The sides of the trough were but ½-in. from the

A RESERVOIR FAILURE AT OAKLAND, CAL.

A reservoir on Vernon Heights, Oakland, Cal., belonging to the Oakland Water Co., failed about 6:30 a. m., Oct. 20. No damage was done beyond flooding basements of houses for a few blocks. The accompanying view was drawn from a photograph taken the next day.

The original reservoir was about 100 ft. square, partly in excavation, lined with brick, and plastered on the inner face with a coat of asphalt. It extended to the height of the ledge shown in the photograph.

To increase its capacity, a wall of asphalt concrete was built around the old reservoir, 8 ft. higher, and connected with the brick and asphalt lining by an 8-in. layer of the same material. This wall was 2 ft. wide at the base and 1 ft. at the



A Reservoir Failure at Oakland, Cal.

top, with its inner face vertical. It had no depth in the ground and no footing, and was built partly on made earth. This upper wall failed. The break showed no bond between the wall and the horizontal layer, but it did show a break in the bond between the upper and lower parts of the wall (also shown by a crack in the wall left standing).

It is stated that previous to the break, water had been carried to within 1 ft. of the top of this wall and at the time of failure it was 22 ins. above the ledge.

The reason assigned by the water company for failure was the explosion of dynamite by some malicious person.

We are indebted to Mr. Geo. S. Dillman, of Dillman & Wallace, San Francisco, for the above information, and for the photograph from which the view was drawn.

NOTES FROM THE ENGINEERING SCHOOLS.

Lehigh University, South Bethlehem, Pa., opened Sept. 23, with a Freshman class of 115, as against 75 last year. The president announced the return of Professor Thornburg, the head of the Mathematical Department, who had been on leave of absence for the past year, and the addition of two new instructors in the departments of Mechanical and Electrical Engineering.

A characteristic feature of the technical instruction at Lehigh University, is the regular and systematic instruction given to the students in the shops of the Bethlehem Iron Company, and the shops of the Lehigh Valley R. R., at South Easton.

On Founder's Day, Sept. 8, Mr. John H. Converse, of Philadelphia, a member of the firm of the Baldwin Locomotive Works, made the annual address. Mr. Converse is a graduate of the University of Vermont, and much interested in educational matters. His address on "Citizenship and Technical Education," which will be published by the University, will attract much attention on the part of engineers and educators. He advocated a college course which should for the first three years be devoted to culture studies and the humanities, and for the last two or three years to professional subjects.

The "Combined Courses," at Lehigh University, which cover five or six years, and lead both to the degree of A. B. and an engineering degree, are largely in the line of Mr. Converse's proposition. The chief objection to the present system of education of engineers in our technical schools is its one-sidedness. If we are to make this education broader we must take more time for it.

Separate pamphlets are issued by the different engineering departments, describing in detail the methods of instruction. We have received three of these pamphlets, describing, respectively, the courses in civil, mining and mechanical engineering.

At the University of Michigan, Mr. John R. Allen, Univ. of Mich., '92, and J. T. Faig, Mich. & Agl. Coll., of Kentucky, '94, have been appointed Instructors in Mechanical Engineering, to fill the place vacated by the resignation of Asst. Prof. F. C. Wagner, who has gone to the Rose Polytechnic Institute, at Terre Haute, Ind.

At the Massachusetts Institute of Technology, the equipment of the engineering laboratories has been increased by the acquisition of new apparatus as follows:

In the laboratory of Applied Mechanics has been added a 100,000-lb. Olsen testing machine, capable of testing specimens 5 ft. long and under. In the same laboratory has been added a frame of two large iron girders, and other suitable apparatus, provided with a set of steel rods, which, with a pair of large cast-iron skewbacks already in the laboratory, make a machine of 400,000-lb. capacity for testing masonry arches of such sizes as are used in practice. To the Mechanical Engineering laboratory has been added a 36-HP. Otto gas engine, which is to be used mainly for purposes of investigation. An apparatus for testing steam injectors has been built and was in use during the latter part of last year. A compound Marsh pump of a capacity of 800 gallons per minute has been loaned to the laboratory for experimental purposes. In the Hydraulic laboratory has been added a calibrated measuring tank of 20,000 lbs. capacity, in addition to the old tank of the same capacity. Each is equipped with ten quick-opening valves, enabling large quantities of water to be measured accurately.

In the double number of the "Technology Quarterly," just issued, dated June-Sept., 1896, will be found Nos. IV. and V. of the "Results of tests made in the Engineering laboratories," No. IV. giving the detailed results of the test of the triple engine of the Chestnut Hill Pumping Station, made in May, 1895, by the students under the direction of Prof. E. F. Miller. No. V. contains the detailed results of tests made in the course of the regular work of the laboratory of Applied Mechanics, on the following subjects:

1. Tests on two series of bolted joints.
2. Tests on wrought-iron pipe of different sizes, used as columns.
3. Tests of spruce and of Norway pine beams.
4. An extensive series of tests of the compressive strength of timber at right angles to the grain.
5. Torsional tests of shafting, mostly 2 ins. in diameter.
6. Tensile tests of specimens of steel and of iron, of wire, of manila, of cotton, of hemp, and of sisal rope, and of the strength of alloys.

During the last school year, in the course of the regular laboratory work, complete tests of two large plants; one a 50-hour test of the West End R. R. Power Station, at Sullivan Square, Charlestown, and one a 24-hour duty test on the triple engine of the Chestnut Hill Pumping Station.

Extensive additions have recently been made to the plant of dynamo-electric machinery. The principal of these are a 30 arc-light Brush machine, a 30-HP. Westinghouse 4-pole direct current machine, and a 10-HP. Westinghouse direct-current machine, arranged so as also to give quarter-phase alternating currents when desired. This machine can also be used as either a direct or alternating current motor, or as a rotary transformer. Two 20-HP. transformers have been added to be used in connection with the large alternator already possessed by the Department. All of this apparatus is for regular use in the laboratory by the students.

There is also under way a new plant especially arranged for illustrating the testing of the combined efficiency of steam engine and dynamos. It consists of two similar multipolar direct-current dynamos, of 35-HP. each, made by the General Electric Co. These will be driven by a separate compound high-speed engine.

A 20-HP. electro-magnetic transformer for heavy currents has also been added to the equipment. This is intended to be used particularly for the study of the heating effects of very strong currents. There has likewise been constructed a transformer giving a pressure of 40,000 volts, whose special use is to determine the electrical strength of materials used for insulating purposes. A large addition has also been made to the storage-battery equipment already possessed by the department.

Many additions have been made to the apparatus for precise measurements in electricity and heat, including special forms of apparatus for studying the errors of standard thermometers, and for determining thermal conductivities. A new standard air condenser should also be mentioned.

The New Mexico College of Agriculture and Mechanic Arts, Mesilla Park, N. Mex., sends us a photograph of its new engineering building. It is a flat-roofed one-story building of a very substantial appearance, and differs in one particular from probably every other engineering college laboratory in the country in being built of adobe, plastered inside and out. The adobe bricks (unburned clay and straw) are laid up in thick walls, making a building cool in summer and warm in winter; and in a land of sunshine and little rain, they make a very durable structure.

The equipment just added has been selected from the Davis & Egan Co., Egan Co., Fulton Steam Boiler Works, Laidlaw, Dunn, Gordon Co., Springfield Emerywheel Co., Weston Engine Co., Standard Scale Co., and other makers. The college offers four regular courses, viz., Agricultural, irrigation engineering, mechanical engineering and scientific. Spanish is thoroughly taught in the college. It is the prevailing language in much of New Mexico, and in all of the country southward.

The dry atmosphere and mild climate of New Mexico are very beneficial to those subject to pulmonary troubles, and the college has been of great service to many students who were unable to pursue such work at the eastern and northern colleges where the climate is more severe.

The engineering work is in charge of Frank W. Brady, M. E. (from Purdue University, Lafayette, Ind.), with Mr. Chas. Mills, assistant.

In the engineering department of the University of Minnesota, prizes for original theses have recently been awarded to students as follows: First prize, $50 and gold medal, to Mr. C. P. Jones, Jr., for thesis entitled, "An Original Design for the Steel Frame of a Ten-Story Building;" second price, $30 and a gold medal, to Mr. C. E. Magnusson, for thesis entitled, "Specifications for an Electric Lighting Plant for the Gillette-Herzog Mfg. Co." This system of prize-giving was instituted five years ago by the Gillette-Herzog Mfg. Co., of Minneapolis, Minn., with a view to stimulating original research in various lines of engineering. Their plan is to offer prizes as described above, placing the papers prepared by students in the hands of a committee composed of prominent engineers.

The Worcester Polytechnic Institute, Worcester, Mass., has made many important changes during the past two years. We are indebted to Prof. Sidney A. Reeve for the following account of them:

News from this Institute can hardly be fully understood without a word as to the general changes which Dr. T. C. Mendenhall inaugurated upon his accession to the presidency and which are only now, some two years later, beginning to be manifest in works. Up to that time the Institute had remained one of the best schools for the training of mechanics which the country afforded. The growth away from this original character has, of course, always been responsive to the changing demands of the changing times; but within a few years this has been accentuated, and the school, still retaining its full original equipment of commercially operated shops, can boast a similarly complete equipment for scientific and technical education.

The Washburn Shops continue to be the centre of the Institute. About them have sprung up in a very few years an array of laboratories, each specially equipped for its work. In chemistry, the special branches of gas-analysis, metallurgy, sanitary and industrial chemistry each have special laboratories, and, with the exception of the first, special professors devoted to them. The department of sanitary chemistry derives special advantages from Worcester's possession of the fine Blackstone River sewage-disposal works, which annually attract a number of experts in that line from all parts of the world.

Applied electricity and electrical engineering now have

new laboratories of their own, with a new chair, occupied by Prof. Harold B. Smith. The lighter electrical work is carried on in the original laboratory, now remodelled; the heavier electrical power work occupies its portion of the new Power Laboratory, of which more will be said later.

The departments of pure mathematics and language have each been enlarged to meet the requirements of increasing classes, and the superintendency of the Washburn Shops has passed into new hands. The most marked advance has been made in the departments of Mechanics and Steam Engineering. As the laboratories devoted to this work are of recent construction and of somewhat novel arrangement, a somewhat detailed description may be of interest.

The Mechanical Department.

The apparatus and work in this line was transferred about a year since to two new buildings erected especially for it from funds coming from the State of Massachusetts. One of these, locally known as the "Power Laboratory," is devoted to the study of questions in steam, electrical, and gas power, all on a commercial scale. The other, known as the "Mechanical Laboratory," is occupied by laboratories for lighter mechanical investigation into problems in general applied mechanics, strength of materials, hydraulics, kinematics and thermodynamics; it also contains an instrument-room, recitation and lecture rooms, and the mechanical and freehand drawing rooms.

The Power Laboratory contains two vertical 80 HP. boilers built for a steam pressure of 200 lbs., three horizontal steam engines, a condenser, absorption dynamometer, and the heavier electrical machinery. In the future it will also be equipped with a 100-HP. gas engine and power gas generator.

The possibilities in the line of combination of this apparatus, by means of clutches, quills, and a countershaft, are almost innumerable. The three engines, whose cylinder-volumes bear the ratio of 1 : 3.06 : 7.84, may be combined into a compound engine by the connection of any two of them, or all three may be run as a triple compound. The speed of any one or all, although all possess automatic cut-offs, may be varied so as to vary these cylinder-ratios to any value between 2 and 10. Any one or any set may exhaust into the atmosphere or into the condenser. Any one or set may be operated with or without steam-jackets, on barrel or on either head, and the jacket-water weighed separately. Between each pair of engines is a live-steam re-heater which may be used or not, and its condensation measured. While any engine or pair is being used experimentally, the other may be used to drive the commercially operated Washburn Shops, which normally consume about 25 HP., and which are driven from the Power Laboratory the year around. Finally, the power from any engine or any set may be carried over to the absorption-dynamometer and there weighed, or may be further transmitted up to any one of the three electrical generators for consumption or measurement.* The near future will add to this array of prime movers an 80 HP. motor receiving current from the Institute's Hydraulic Power Laboratory at Chaffinsville, five miles north of the city, and which may be similarly coupled in with the other apparatus in almost any combination. This hydraulic power laboratory, containing an 80 HP. turbine using the drainage from a 2,500-acre watershed under a 30-foot fall, with Venturi meter, absorption dynamometer, 10-ft. weir, and all accessory apparatus, constitutes practically a department of itself.

The circulating-water from the power-laboratory condenser is carried back to the Mechanical Laboratory building, where the laboratory hydraulic apparatus admits of its being measured by orifice, by weir, or by weight, or by all three in series. The same hydraulic apparatus of course is prepared for all experimental work in hydraulics itself, for which purpose water is supplied from a pressure-tank in the laboratory, for all heads up to 200 lbs. per sq. in. The tank is now being equipped with a mercury-column 33 ft. in height for standard orifice work, but which will also be used for testing gages or any other incidental work of the sort.

On the same floor are the testing machines: a 100,000-lb. Emery, a 50,000-lb. Fairbanks vertical, a Riehle torsion, and a Riehle light tension for wire and cement; to these is being added a 20,000-lb. Wicksteed lever-machine. The first of these machines is operated by water-power from the pressure-tank, under a system which permits the most delicate gradation of load and the retention of the load at any point almost independently of leakage. The others are operated by hand-power or belt-power.

Amongst the interesting work recently done by this section of the laboratory was the destruction by crushing of sixteen specimens of concrete of different compositions for a prominent firm of contractors and builders. The specimens were bedded in a mortar of plaster-of-paris, which was allowed to set while the specimen was under a strain of a few hundred pounds. The method of giving way to the strain which all of the specimens except three exhibited—that is, the leaving on the heads of the machine a pair of cones of material almost uninjured—gave rise to doubts as to whether the results were not more favorable to the concrete than would be the case in actual practice. It is perhaps, however, the only method of reducing the test-results of different mixtures and machines to a just basis for comparison. The following table gives the results of the compression tests of concrete cylinders, Sept. 28 to Oct. 1, 1896, axial compression:

		—Dimensions.—				——Strain—Lbs.——		
Mark.		Length, inches.	Cross-section, sq. ins.	Weight, lbs.	oz.	First crack.	Ultimate.	Per sq. in.
AT	1	8.15	28.22	18	12	25,000	26,900	954
AL	1	8.10	28.32	18	14	18,200	22,700	802
D	1	8.05	28.22	..	..	22,500	22,500	800
G	1	8.08	28.20	18	12	28,000	28,900	1,025
S	1	8.11	28.32	18	11½	20,400	27,200	961
R	1	8.08	28.22	17	7½	3,000	6,200	220
AT	2	8.11	28.04	..	..	89,900	89,900	3,210
S	2	7.97	28.13	17	11½	89,600	89,600	3,190
AT	3	8.12	27.94	..	..	19,000	35,800	1,280
S	3	8.06	28.32	18	9½	51,200	51,200	1,810
AT	4	7.98	28.13	18	9	25,500	28,500	1,013
S	4	8.06	28.41	18	7½	33,800	34,800	1,225
AT	5	12.12	50.68	52	11	Strained to 100,000 lbs. without apparent injury.		
S	5	12.13	50.36	50	15	64,400	69,100	1,371
D	5	12.17	51.06	50	11	81,400	82,200	1,609
G	5	12.11	50.30	52	2	99,100	100,000	1,988

NOTES.—The mixtures had set about 30 days, the exact time being unknown in the laboratory.

AT 3 was not well filled out on one side with sand and cement—irregular, elongated cavity about ½ in. wide and deep.

S 3 was full of small cavities on outside.

G 5 was not well filled out on a complete circle about 1½ in. from one end; but specimen did not give way there.

The mixtures were in proportions indicated by the numbers as below, the stone of No. 2 being fine stone of 1½ in. mesh.

No.	Stone.	Sand.	Cement.
1	5	2	1
2	2	1	3
3	4	2	1
4	6	3	1
5	4	2	1

The letters indicate different brands of cement.

Some recent tests of interest were made upon steel strips cut from a rifle-barrel which had been in actual use.

A recent acquisition in this connection has been an optical extensometer which reads, and with accuracy, verified within the limits of probability, to $\frac{1}{20,000}$ in. in 8 ins.

This same laboratory contains, besides the hydraulic apparatus already mentioned, a special small surface-condenser and three experimental steam-engines for thermo-dynamical problems. It is expected that a refrigerating and ice-making machine, erected solely for experimental and illustrative purposes in thermodynamics, will be shortly installed.

The department of drawing, which occupies the top floor of this same building, has recently received a new head, Prof. Ames, who is remodelling the course so as to unify all the branches—free-hand, mechanical drawing, and machine design—and all the four years' work, so as to lead towards a complete and homogeneous education in that direction.

In the electrical engineering department a post-graduate course has been established, which includes 14 hours per week of laboratory work, and 12 hours of electrical engineering design, besides lectures, reviews of current electrical literature, etc. The following new electrical machines are being placed in the Power Laboratory: A 30 K-W. 110-volt compound direct current dynamo, and one of 60 K-W. 500 volts; a 30 K-W. 1,000-volt single phase constant potential alternator, and a 60 K. W. 3,000-volt 3-phase motor to take current from a generator located at the hydraulic power plant of the Institute at Chaffinsville.

The Colorado State School of Mines is about to apply to the coming session of the legislature for an extension of space, the applications for admission having overrun the capacity of the present buildings. The summary of attendance shows that 33 per cent of the students are from outside of Colorado.

*Some preliminary tests of these engines will illustrate this opportunity of varied combination. While the middle engine of the three was driving the Washburn Shops upon 60 lbs. non-condensing, the first and third were running condensing under 110 lbs. of steam under a brake and indicated efficiency test. The water consumed was 15¾ lbs. per I. HP. per hour. After the test the shops were transferred from one engine to another without any interruption whatever.

DERAIL FOR THE GIBBS ELECTRIC STREET RAILWAY INTERLOCKING DEVICE.

The greatly enlarged liability to serious grade-crossing accidents, which has followed the rapid increase of high-speed electric railways, has become so evident by frequent collisions and still more frequent narrow escapes that the need for a suitable protection for such crossings is now seldom questioned. It is also quite generally recognized, in the most advanced practice, that the old highway crossing gate is inadequate to the conditions of heavy, high-speed electric cars not infrequently rendered uncontrollable by the blowing of a fuse or jumping of the trolley, and that the logical solution of the problem is along the lines of the mechanical interlocking signals used at steam railway grade crossings. In our issue of Feb. 22, 1894, a special interlocking plant of this character, invented by Mr. Geo. Gibbs, M. Am. Soc. M. E., Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry., was described in some detail, and since that time the device has come into quite extended use along the lines of that company and on other railways.

The particular characteristics of Mr. Gibbs' device, as will be remembered, are: (1) the motive power of the electric cars is cut off when it is necessary to block the line; (2) a derailing device is provided to prevent the cars from drifting over the crossing. This derail resembled the scotch block sometimes used with steam railway interlocking apparatus rather than the derailing switch proper, and has recently been supplanted by Mr. Gibbs with a device more nearly approaching the ordinary derail. Through the courtesy of the inventor we are enabled to present herewith details of this improvement.

A brief consideration of the structure of the ordinary derailing switch will show its inapplicability to street railway tracks. It breaks the continuity of the rail, weakens the track, and affords an opportunity for destructive battering which can only be prevented by assiduous attention in keeping the joints tight and the ties well surfaced and tamped. In street railways the position of the ties and rails below the pavement renders impracticable this attention, and further the construction is an obstruction to wagon traffic, and is especially liable to clogging by mud and ice. The attempt was made to overcome all these difficulties in the derail illustrated. As will be seen by the illustrations it consists of two cast-iron boxes, bolted to each side of the rail through the web, and a cast-steel plate sliding on these blocks through a passage provided by cutting out

Fig. 1.—Derail Closed.

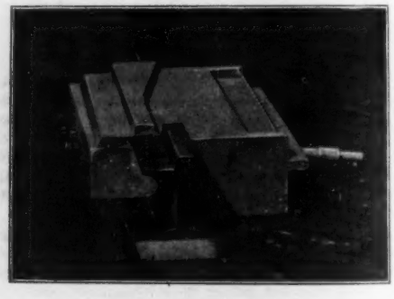


Fig. 2.—Derail Opened.

VIEW OF DERAIL FOR GIBBS' ELECTRIC STREET RAILWAY INTERLOCKING SYSTEM.

the rail head for a distance of 26 ins. Cast on the top of the sliding plate is a suitable projection or ridge to replace the rail head cut away, when the derail is closed, as shown by Fig. 1. Fig. 2 shows the derail in the open position, that is thrown to one side, so as to break the track and derail the car. It should be noted here that the apparently narrow flangeway is due to the fact that when the photograph was taken the sliding plate had not been fully thrown open. In Fig. 3 the details of the various parts of the derail are clearly shown and need not be described further.

The features to be noticed particularly in this device are: (1) The web and flange of the rail are left intact, only the head being cut away; (2) the device is applied to the rail by bolting through the web, and consists of two cast-iron boxes which have footings on the same crossties which carry the rail. Owing to this fact it is not necessary to make a special foundation for the derail or in any way to disturb the ties and their bedding; (3) a smooth surface is presented at a level with the street paving for the passage of wagon traffic; (4) the sliding plate has beveled edges to make it self-cleaning from mud or snow and ice; (5) all operating parts are protected from injury; (6) the operating rod or pipe is attached about 4 ins. only under the surface of the street, by which difficulty from drainage in deep boxes is avoided.

A number of derails of this construction have been put into use, the latest having been recently installed at Indiana St., Chicago, Ill., in a plant built by the National Switch & Signal Co. All of these have worked satisfactorily, being easily operated by the levers and infallibly derailing the cars as has been demonstrated on several occasions. It is stated that in passing over this derail no perceptible jar is felt, indicating that there is no deflection of the track by reason of the cutting away of the head of the rail.

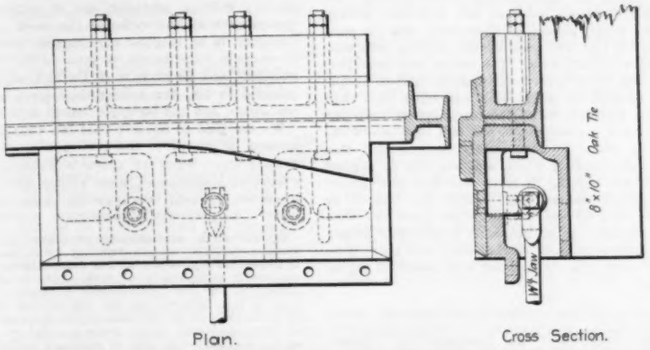


FIG. 3.—DETAILS OF DERAIL FOR GIBBS' ELECTRIC STREET RAILWAY INTERLOCKING SYSTEM.

RAILWAY TERMINAL STATIONS.*

The passenger movement at terminal stations is composed of three classes: 1, Through or long distance; 2, suburban or short distance; and, 3, excursion or irregular travel. In addition to these three classes of travel, it is generally necessary to provide for express and mail matter, and in many cases for the handling of milk.

The long distance passengers have a large amount of baggage, some of which can be taken directly to or from the train, but a large proportion requires provision for storage, and all requires provision for handling while at the station. Passengers of this class usually upon arrival go to their destination by some conveyance, either carriage or street car, so that the location of the station is of less importance to them than to those of the second class. Its arrangement as to comfort of waiting rooms and convenience of baggage rooms is of greater importance. Many passengers of this class wish to take the cars of some railway other than those of the road upon which they arrive. If the trains of both railways are in the same station, with convenient provision for the prompt transfer of the passengers and their baggage from one to the other, their comfort and convenience are served in the best manner. This result is reached in many of the union stations which have become common within the last few years.

The second class of traffic, including the greatest proportion of passengers using the terminal station, including all passengers whose work calls them to the city daily, have very different requirements. They do not need such provision for baggage nor waiting rooms. They reach the station just before the time of departure of their trains and hurry from their trains immediately on arrival. Inside the station, convenient ways for quick ingress and egress are the primary requirements, with a good system of running and despatching trains, and conspicuous and plain indicators showing destination and starting time of trains. To this class, the location of the station is of great importance, and for it, on general principles, the station should be as near the business centre as possible. If this class of business is to be attracted to the railway, the facilities offered and cost of transportation must be as favorable as those of competing lines. The majority of this class are people with small incomes, to whom the addition of a street car fare daily to the steam car fare is a serious expense, hence the necessity of bringing them as near to their places of business in the city as possible.

For the third class noted above, the location of the terminal station does not play so important a part, neither does the arrangement of waiting rooms and baggage rooms. The main features needed are large space and free egress from the trains for the excursion crowds. Care is needed also to have the train indicators plain and conspicuous, and proper provision for preventing crowds from going to the wrong train.

At first the steam railways took the larger share of suburban traffic. As the territory along their lines within reasonable distance of the city became built over, it became necessary to develop the territory between them. This was at first done by omnibuses and horse cars. It has become necessary to build farther from the business centers and farther from the suburban stations of the steam railways. The heavy passenger traffic brought about by the latter movement and the absence of branch feeders to the steam railways, has enabled the electric railways to develop and extend the street systems formerly operated with horses, and, by the superior facilities offered, to bring such competition as to seriously affect the earnings of the suburban steam lines. To meet this competition successfully, the steam railways must have better facilities than were called for by the small traffic of former times.

It may be interesting to show the number of passengers carried by the railways entering Boston during 1894:

	Total.	To and from Boston.
Boston & Albany	12,152,000	7,546,000
N. Y., N. H. & H.	44,448,000	13,831,000
New England	8,146,000	3,426,000
Boston & Maine	33,385,000	21,654,000
Fitchburg	7,117,000	4,055,000

Arranging these figures in groups according to the railways which use the north station and those which will use the new south station, the distribution is as follows:

	Total.	To and from Boston.	Trains per day.
North station	40,448,000	25,709,000	574
South station	64,502,000	24,803,000	678

After the location of a terminal station has been determined, the point next in importance is the arrangement of the buildings and tracks. The headhouse usually contains the waiting rooms for passengers, with ticket offices, toilet rooms and lavatories for men and women, news stands, restaurants, telegraph and telephone offices and information offices. It is also necessary to provide for baggage and express rooms, and often a place for the milk traffic. Besides the above noted rooms pertaining directly to the passenger traffic, provision must be made for many things incident to such traffic, such as rooms for trainmen, sleeping car companies and station officials, store rooms and other rooms for uses connected with the passenger business, but not used directly by the passengers.

In general, the station should be so designed that baggage, express goods and milk, with such other articles as may be received or delivered at the station, shall be handled either below or above the level of the tracks, and in most cases it must be below such level. There are several reasons why such an arrangement is desirable. The movement of passengers and of trucks conveying baggage on different levels makes it safer and easier for people to make such movements as are necessary or desirable about the station. The risk of injury to passengers is much reduced, and less platform room is required for the same amount of business. The movement of both passengers and goods can be made promptly.

On the score of economy of space and cost of land, it is better to have all work pertaining to baggage and freight under the headhouse and trainshed below the level of the tracks, thus making two uses of the ground area, which is quite an important saving where land has such value as is generally the case near the business centers of cities. Such an arrangement renders it possible also to give more and better space to carriages and teams receiving and delivering baggage and goods, also to separate the receiving and delivering points for the various classes of traffic in the station.

With the tracks above the level of the surrounding streets, passages can be made from the tracks to the streets by the most direct course, enabling passengers arriving on trains to disperse much more easily and quickly than if they are obliged to all pass along the platform and out through the headhouse. At times of extraordinary movement of passengers, this is quite an important element in their safe and prompt movement. Objection is sometimes made to such an arrangement, that it renders it necessary for passengers to go up or down stairs and that elevators are needed for the use of passengers. With careful planning, however, inclined ways can generally be provided which can be used by such passengers as object to climbing stairs.

Placing the tracks at a higher level admits of crossing above the streets near the station, avoiding the necessity of crossings at grade or of expensive changes of streets, which in important cities carry with them not only the great direct expense of making the changes, but also a greater indirect expense in the detrimental effect on the value of property. It is also generally possible to obtain better architectural effects with the tracks above the street level, as is well shown in many of the stations recently built in London and various German cities and notably in the terminal stations in Philadelphia.

Generally at terminal stations, space is allowed for carriages and cabs to stand while waiting for inward trains. In many English stations, a wide space between platforms at which long-distance trains arrive is devoted to this use, so that passengers leaving the cars can go directly across the platform into the cab. A practical objection to providing room for carriages under cover is that it is impossible to keep such places clean and free from odor.

In designing a trainshed, if the cost can be ignored, a roof of large clear span is desirable, but with most railways it is necessary to consider the first cost, and as short spans with rows of posts between the tracks give the greatest economy in construction, this plan has been followed in many of the trainsheds recently built. With the improvements in the manufacture of glass, it has become possible to make a large portion of the roof covering transparent, thus giving good light to the interior of the trainshed. The greatest objection to the use of short spans with posts is the trouble experienced in taking care of snow and the difficulty of keeping the roof tight.

Platforms between tracks should be of some hard material which can be easily kept clean. The surface of platforms should be on the same level as the top of rails, so that baggage trucks and other wheeled vehicles can pass from one platform to another upon the same level, thus doing away with the need of moving such vehicles on the same platform with passengers taking or leaving trains. This construction is also safer for passengers, especially for those who get on or off moving trains.

Unless there is some very serious practical objection, inward long-distance trains should always enter on one side of the trainshed, and outward long-distance trains depart from the other side, although such an arrangement may cause more crossing of trains on tracks outside the trainshed. The middle tracks, those between the inward and outward tracks devoted to long-distance trains, should be used for short-distance suburban trains. These suburban trains can enter the station, discharge the inward passengers and take on outward passengers without switching, another engine backing onto the train and hauling it out, relieving the engine which brought the train in. This engine can follow the train out, going to some place where provision has been made for turning and taking water ready for the next trip.

The tracks in trainsheds are usually arranged in pairs, with a platform between each pair of tracks. For suburban trains it might be well in some places to lay three tracks together, in order to allow the locomotives to pass around the trains and avoiding the necessity of drawing the train out of the station before loading it for its outward trip. For tracks on which inward trains having a large amount of baggage and express goods arrive,

*Abstract of a paper read by Mr. E. K. Turner, M. Am. Soc. C. E., at a meeting of the New England Association of Railroad Superintendents, at the United States Hotel, Boston, Mass., Oct. 12.

it might be well to change the above arrangement by placing a narrow platform between the tracks of a pair, and using this platform for baggage and express trucks, thus keeping the regular platform free for the movement of passengers, avoiding what in many stations is a serious inconvenience.

The modern application of interlocking switches and signals, with the improved methods of handling both switches and signals, together with the good track appliances and material now obtainable, makes it possible to do many things safely and promptly with moving trains that would a few years ago have been impossible, so that the crossing of trains from one track to another is now admissible, removing the principal objection to the arrangement of trains alone recommended. It is possible to have a terminal station too large, for anything beyond the room required for active use is not only wasted, but is positively objectionable. It increases the distance of those parts of the station between which passengers and employees must pass; it furnishes room for standing cars which should be stored elsewhere, and it leads to carelessness and lack of neatness in the care and policing of the station. Therefore, while a proper provision for growth of business should be made, care should be used not to carry this to an extreme.

BOOK REVIEWS.

A MANUAL OF STEAM BOILERS.—Their Design, Construction and Operation. For Technical Schools and Engineers. By R. H. Thurston, M. A., LL. D., Dr. Eng., Director of Sibley College, Cornell University. Fifth edition, revised and enlarged. New York: John Wiley & Sons. 1898. 8vo.; pp. 881; $5.

This well-known work has now reached its fifth edition. It has been brought up to date by the addition of a good deal of new matter, among which we notice condensed reports of the tests on steam boilers recently made in England by Messrs. Donkin & Kennedy.

LOCOMOTIVE MECHANISM AND ENGINEERING.—With an Appendix on the Modern Electric Locomotive. By H. C. Reagan, Jr., Locomotive Engineer. Second Edition. New York: John Wiley & Sons. Cloth; 8vo.; pp. 419; illustrated. $2.

The first edition of this book was reviewed in our issue of April 19, 1894, and the principal addition to the second edition is the appendix on electric locomotives, which occupies nearly 100 pages. The book deals largely with the handling and emergency repairing of locomotives, while nearly 100 pages are devoted to modern types of American compound locomotives, and 80 pages to matters connected with the brakes. In the appendix the general operation of electric motors is described at some length, and particulars are given of the construction of the Baltimore & Ohio R. R., Sprague and Heilmann (French) electric locomotives. The book is written in a style easily comprehended, is well printed in large clear type, and is fully illustrated.

EXPERIMENTS UPON THE CONTRACTION OF THE LIQUID VEIN issuing from an Orifice and upon the Distribution of the Velocities within it. By H. Bazin, Inspecteur Generale des Ponts et Chaussees. Translated by John C. Trautwine, Jr., Civil Engineer. New York: John Wiley & Sons. 8vo.; pp. 64; with diagrams. $2.00.

The author is already well known to engineers by his studies of the flow of water in open channels, made in connection with M. Darcy, and by his careful determination of the coefficients of discharge under widely varying conditions. In the present work, admirably translated by Mr. Trautwine, M. Bazin deals with the contraction of the liquid vein and the velocities within it, as observed in passing through rectangular and circular orifices in both vertical and horizontal walls. He treats of the method of determining the coefficient of discharge, the geometrical figure and transverse section of the vein, and, by a modified form of the Pitot tube, he ascertains the velocities in the vein and the distribution of these velocities. In his resume he says that his experiments do not show the generally-admitted existence of a contracted vein, if that expression is taken in the sense of a minimum section. In reality the vein, after being rapidly contracted upon passing the orifice, always continues to contract, much more slowly but constantly, as its distance from the orifice increases. While there is no doubt as to the absence of the minimum of section for veins issuing from circular and rectangular orifices there may be some doubt as to the square orifice, experimented with. In the distribution of the velocities in the plane of the orifice there is a minimum; in circular orifices in a horizontal plane this minimum is, of course, in the center and in vertical orifices it is a little above the center of gravity of the section. In the case of circular horizontal orifices the velocities are rapidly equalized as the distance from the plane of the orifice increases, and they soon become uniform through the entire transverse section. But this is not the case with orifices in a vertical plane; the minimum existing in the central region soon disappears, but the velocities in the lower part of the vein remain greater than those in the upper part. M. Bazin presents full data for all his conclusions, and gives in tabular form a long series of experiments in the determination of the velocities and of the pressures in the interior of the liquid veins.

DIE SCHWINGUNGEN EINES TRAEGERS MIT BEWEGTER LAST. (The vibrations of a girder under a moving load.)—By Dr. H. Zimmermann, Geheimer Ober-Baurath. Pp. 46; illustrations in text; 4 lithographed plates; paper; 8vo. W. Ernst & Sohn, Berlin. 1896. Price, M. 6.00 ($1.50).

In the calculation of the strains in a girder, due to static load, it is generally assumed that the live load in its various positions rests upon the girder; the fact is, however, that the live load often traverses the girder or truss with considerable speed.

The girder changes its outline under the passing live load; the latter, therefore, does not move in a straight line, but describes a curve. The movement of a body in a curved line is influenced by a centrifugal force, which depends upon the mass and the speed of the moving load. The pressure which the load exerts upon the girder is therefore dependent upon the bending moment of the latter and the speed of the passing live load; this pressure then causes the bending of the girder and incidental curvature of the line traversed. Intricate, as the law of the mutual dependence of these two factors may appear, it will still admit of mathematical investigation. Attempts in this direction have so far, however, utterly failed, as the error generally committed was to confound the curved line traversed by the moving load with the elastic curve of the girder. The author has attempted to treat this difficult subject from a mathematical standpoint. The method of integration employed here will yet admit of a solution, when the force acting upon the moving load is not unchangeable, but is a function of the position of the load. It need hardly be said that this is a piece of hair-splitting which will scarcely be applied in practical bridge design. It is an excellent example of the "mathematical engineering" which has caused so many practical men to look with distrust upon the work of technical schools. It is, however, a perfectly proper field for the student of pure mathematics, and there is no reason why it should be confounded with practical engineering studies.

A PRIMER OF THE CALCULUS.—By E. Sherman Gould, M. Am. Soc. C. E. Van Nostrand's Science Series No. 112. New York: D. Van Nostrand Co. 16mo., boards; pp. 91; with 17 folded plates. 50 cts.

The object of this little book is well expressed in the following words from the preface:

This work is a development of the infinitesimal calculus as far as the first differentials of algebraic functions of one independent variable and their corresponding integrals. That is to say, it is restricted to the absolute rudiments of the science. Within these narrow limits, however, the treatment is tolerably full, and suffices to show how far-reaching a mathematical instrument the calculus is, even in its elementary steps. This seems to the author to be the best way of communicating a working knowledge of the science; namely, to teach a few elementary rules and then put them into immediate use, as far as they will go. The student then recognizes the necessity of the more advanced steps.

The ideas of the author, as expressed in the above extract, appear to be most excellent, and his methods of carrying them out in the book are admirable. He seems to have written the book with the intention of furnishing an easy introduction into calculus to the beginner of the study, and of making it interesting from the start by giving numerous practical examples of its application. We think, however, that the book may also be found useful to another large class of students, namely, those college graduates who toiled through calculus during their course with the object of passing an examination in it, and then proceeded as rapidly as possible to forget all about it. To many such students there comes a time in after years when they wish they could remember something of the subject, and to them this book may be useful as a refresher of their memories; in fact, it may offer to them a new view of a science which may thereafter prove to them a useful tool. The time at the disposal of the present reviewer will not allow of any critical examination of a mathematical work like this, but a rather hasty reading of the text shows it to be generally quite clear and accurate. Exception, however, must be taken to a couple of sentences on p. 29. The first is:

The province of the calculus is to deal with ratios, which while constant as between the variables, are constantly changing as to their numerical values.

The meaning of the words "constant as between the variables," is not very clear, and the author in attempting to explain the sentence gives the differentiation of the equation of the parabola and then says the differential coefficient $dy \div dx$ "is the constant ratio of the infinitesimal increase of the ordinate to the infinitesimal increase of the abscissa, but it is changing its numerical value by infinite gradations." As the ratio $dy \div dx$ in the parabola has a different numerical value for every value of x, we cannot see how in any sense it can be considered a "constant." For the word "constant" the word "finite" should apparently be substituted, and the word "infinite" is, apparently, a misprint for "infinitesimal."

THE MANUFACTURE AND PROPERTIES OF STRUCTURAL STEEL.—By Harry Huse Campbell, S. B. New York and London: The Scientific Publishing Co.; 8vo.; pp. 397. $4.

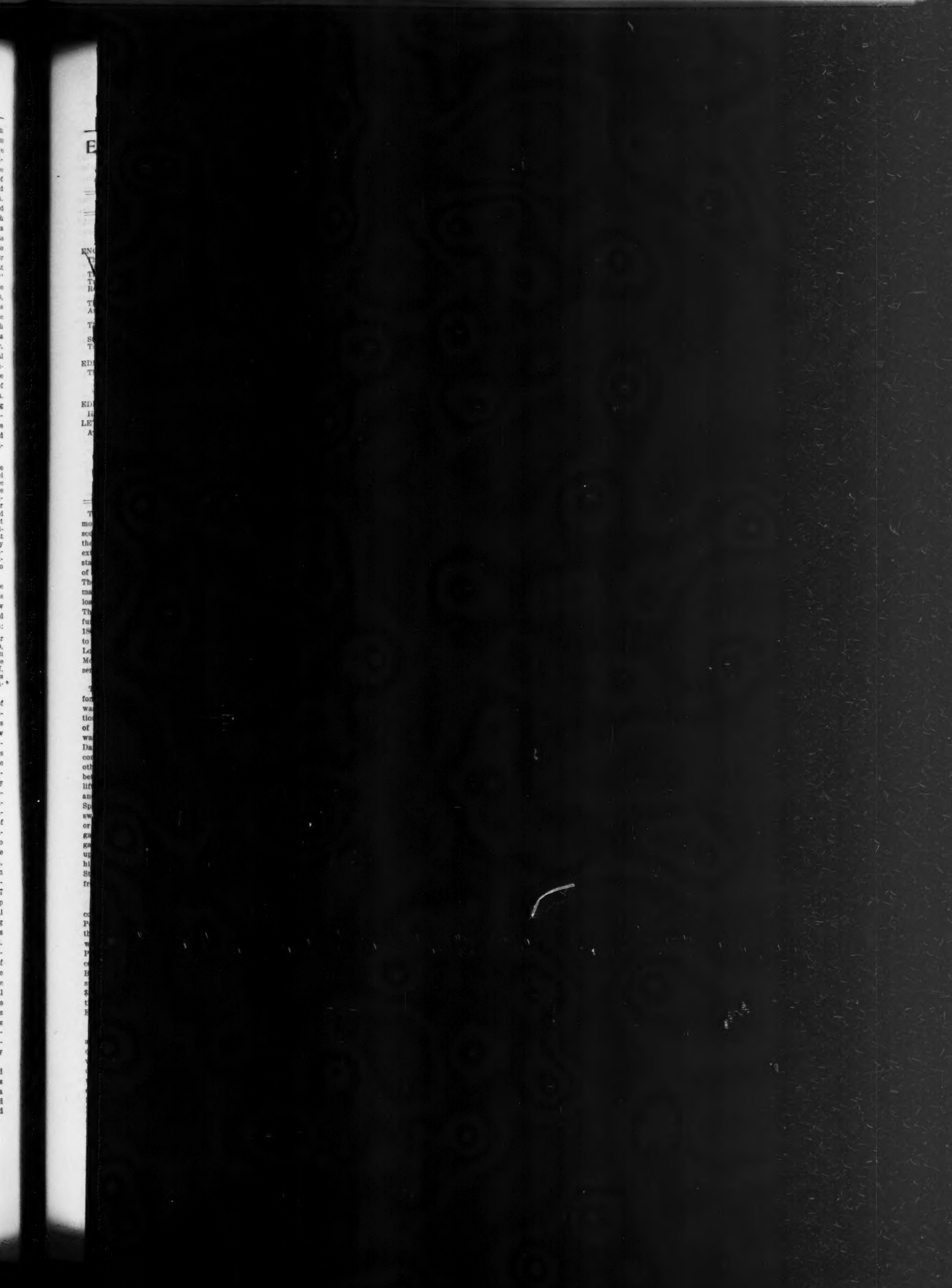
Mr. Campbell is the superintendent of the Pennsylvania Steel Co., at Steelton, Pa., having been connected with that company since 1879, shortly after his graduation from the Massachusetts Institute of Technology. During the last few years he has contributed several papers on the subject of steel to the Transactions of the American societies of mining and civil engineers, which have shown an unusual amount of scientific study and experiment for one practically engaged in manufacture. The volume he has now produced is filled with matter of great value to every student of the subject of steel, and especially to the engineer who uses steel in construction. Mr. Campbell is not a professional writer of books, and the reviewer from a literary standpoint might find much in it to criticise. For instance he writes as if all his readers were well-versed in steel technology, whereas many of them will be young students who would like to have his definitions more clearly explained. Thus under the head of the Acid-Bessemer Process, he states that the operation is conducted in an "acid-lined vessel." This may be perfectly clear to those familiar with the difference between the "acid" and the "basic" processes, but it might be well to explain that the "acid lining" is made of fire-brick or ganister high in silica, while the "basic" lining is one high in lime and magnesia. Such literary defects, however, are of trifling importance as compared with the value of the work as a whole. Mr. Campbell is an original investigator, he has a great deal of valuable information to give as the results of his researches, and he gives it in his own way. We should be grateful to him for having thus given us the results of his labors, and not be hypercritical as to its literary form.

We are glad to observe that Mr. Campbell takes strong ground in regard to the retention of existing trade nomenclature. Thus he closes a discussion in which he unsparingly castigates those writers who have endeavored to thrust into our language the terms "weld-iron, ingot-steel," etc., by the following:

By the term wrought iron is meant the product of the puddle furnace or the sinking fire. By the term steel is meant the product of the cementation process, or the malleable compounds of iron made in the crucible, the converter or the open-hearth furnace. This nomenclature is not founded on the resolutions of committees or of societies. It is the natural outgrowth of business and of fact, and has been made mandatory by the highest of all statutes—the law of common sense. It is the universal system among engineers not only in America but in England and in France. In other lands the authority of famous names, backed by conservatism and governmental prerogative, has fixed for the present, in metallurgical literature, a list of terms which I have tried to show is not only deficient, but fundamentally false.

In regard to the recent controversy concerning the elastic limit and the "yield point," Mr. Campbell takes equally strong ground, quoting from the editorial review of the subject in Engineering News of July 25, 1895, and approving the position there taken in the following words:

These conclusions represent common sense in their summary dealing with the petty theories of enthusiasts, who are so wrapped up in the accurate determination of a micrometrical measurement that they ignore the more important variations inherent in the method itself, not to mention the still more overwhelming differences caused by changes in the history and shape of the material.

The first chapter of the book is entitled "The Errancy of Scientific Records," and is devoted especially to a discussion of the differences in results of chemical analysis of steel as obtained by different chemists. Then follow chapters on pig iron, on wrought iron, and on the several metallurgical processes by which steel is made. This portion of the book, which occupies about a quarter of the whole, will be of interest chiefly to metallurgical students. The remainder of the work appeals more directly to the structural engineer. It contains chapters on homogeneity and segregation, influence of hot working, annealing, the history and shape of the test piece, the influence of certain elements on the physical properties of steel, classification of structural steel, welding, steel castings and inspection. A great deal of space is given to a mathematical investigation by the method of brace squares, of the problem what is the influence of carbon, phosphorus, manganese, copper, sulphur and silicon upon ultimate tensile strength. To solve this problem, the records of 1,880 test pieces were taken, combined into 137 groups, and the average chemical analysis of each group was obtained. An enormous amount of mathematical work was performed upon this mass of data, resulting in the conclusion that the method of least squares is inapplicable to the problem if all the data are included. Thus the mathematical solution gave the absurd conclusion that .06% of sulphur would increase the strength of steel 22,000 lbs. per sq. in., when in fact it would cause only a very slight increase, if any. By neglecting the factors silicon, copper and sulphur from the mathematical equation and applying the method of least squares to the remaining factors, equations were reached which gives results which are probably as close to actual test records as any formula for relation of strength to chemical analysis can possibly give, although individual tests will frequently show wide differences from the result given by the formula.

The chapter on inspection should be carefully read by every one who has occasion to draw specifications for steel contracts. Dishonesty of manufacturers is a "sad fact" to which Mr. Campbell calls attention, and his exposure of some of the tricks of the trade should have a salutary influence.